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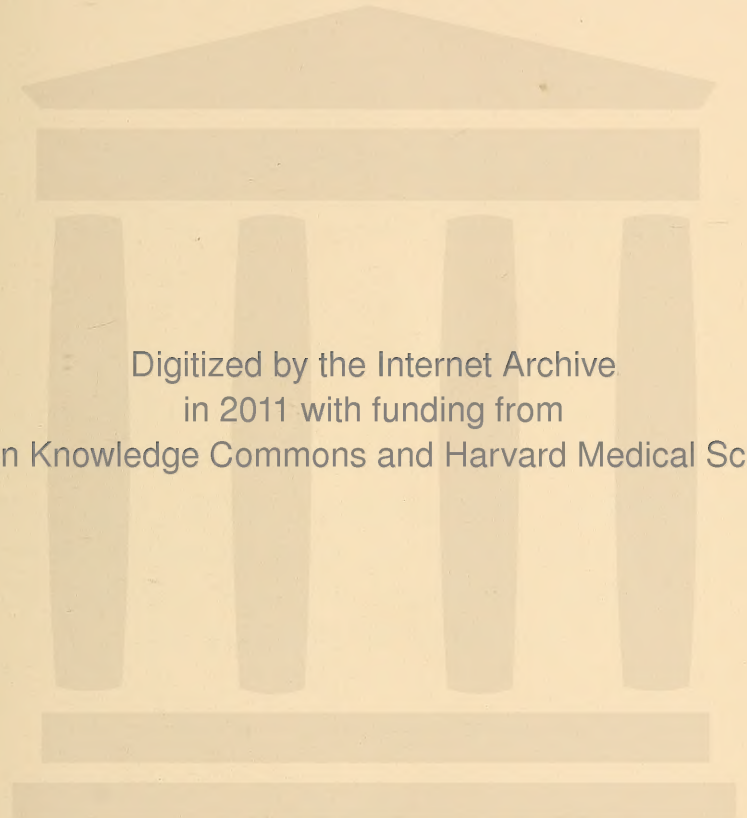
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A

SYSTEM

OF

PRACTICAL THERAPEUTICS.

EDITED BY

HOBART AMORY HARE, M.D.,

PROFESSOR OF THERAPEUTICS AND MATERIA MEDICA IN THE JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA; PHYSICIAN TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL.

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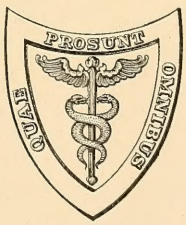
VOL. I.

GENERAL THERAPEUTIC CONSIDERATIONS—PRESCRIPTION-WRITING—REMEDIAL MEASURES OTHER THAN DRUGS—PREVENTIVE MEDICINE—DIATHETIC DISEASES AND DISEASES OF NUTRITION.

WITH ILLUSTRATIONS.



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PREFACE.

THESE volumes have been prepared to present in a useful form what is known of the best methods of treating disease.

While they are based upon the System of Therapeutics which was published ten years ago, nearly one-half of the articles are entirely new, and the rest of the material has undergone a most complete revision. The scope of the work has further been enlarged so as to place in the hands of the practitioner a larger amount of information covering the entire field of medical and surgical therapeutics.

Among those subjects which have thus demanded new presentation may be mentioned Diabetes Mellitus, Diphtheria and Spasmodic Croup, Scarlet Fever, Measles, Rötheln and Varicella, Typhoid Fever, Croupous and Catarrhal Pneumonia, Dengue, Influenza, Acute Rheumatism and Tonsillitis, Mumps and Diseases of the Mouth, Diseases of the Liver and Gall-bladder, Tuberculosis, Rickets, Scurvy, the Diseases of Pregnancy, Parturition and the Puerperium, Fractures and Dislocations, Antisepsis and Asepsis, Anæsthetics, Minor Surgery and Bandaging, Disinfection, Mineral Springs, Swedish Movements and Massage.

The illustrations have also been largely increased in number.

The System of Therapeutics may therefore fairly claim to represent with completeness the practical aspect of the therapeutic art as it exists to-day, and should prove an efficient aid in medical practice.

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CONTRIBUTORS TO VOLUME I.

BAKER, HENRY B., A. M., M. D.,

Secretary of the State Board of Health, Lansing, Michigan; Ex-President American Public Health Association.

BANKS, CHARLES EDWARD,

Surgeon and Medical Purveyor United States Marine Hospital Service, New York.

BARUCH, SIMON, M. D.,

Visiting Physician to the J. Hood Wright Memorial Hospital, Consulting Physician of the Montefiore Home for Chronic Invalids, New York.

CHRYSTIE, WALTER, M. D.,

Attending Physician to the Bryn Mawr Hospital, Bryn Mawr, Pa.

COPLIN, W. M. L., M. D.,

Professor of Pathology and Bacteriology in the Jefferson Medical College; Pathologist to the Jefferson and Philadelphia Hospitals; and Bacteriologist to the Pennsylvania State Board of Health.

CROOK, JAMES K., A. M., M. D.,

Adjunct Professor of Clinical Medicine and Physical Diagnosis at the New York Post-Graduate Medical School; Attending Physician to the Post-Graduate Hospital, etc.

FLICK, LAWRENCE F., M. D.,

President of the Free Hospital for Poor Consumptives; Ex-President of the Pennsylvania Society for the Prevention of Tuberculosis; Fellow of the College of Physicians of Philadelphia, Member of American Public Health Association, and Philadelphia County Medical Society.

HARTWELL, EDWARD MUSSEY, PH. D., M. D.

Secretary of Statistics Department, City of Boston; Late Director of Physical Education in the Public Schools of Boston; sometime Associate in Physical Training in the Johns Hopkins University, Baltimore.

MARTIN, EDWARD, A. M., M. D.,

Professor of Clinical Surgery, University of Pennsylvania; Surgeon to the Philadelphia, St. Agnes', and Howard Hospitals; Consulting Surgeon to the Bryn Mawr Hospital and the State Hospital for the Insane, Norristown, Pa.

MELTZER, S. J., M. D.,

Attending Physician to Harlem (City) Hospital, New York; Member of the Association of American Physicians, American Physiological Society, etc.

MITCHELL, JOHN K., M. D.,

Assistant Physician to the Infirmary for Nervous Diseases; Neurologist to the Presbyterian Hospital.

MOORE, ROBERT E.,
Late Instructor in Massage in the Orthopædic and Polyclinic Hospitals.

REMINGTON, JOSEPH P., PHAR. D., PH. M., F. C. S.,
Professor of Theory and Practice of Pharmacy in the Philadelphia College of Pharmacy.

ROCKWELL, A. D., A. M., M. D., NEW YORK.

SOLLY, S. EDWIN, M. D.,
Ex-President of the American Climatological Association, Colorado Springs, Colorado.

STEWART, JAMES, M. D.,
Professor of Medicine and Clinical Medicine in McGill University, Montreal; Physician to the Royal Victoria Hospital.

TYSON, JAMES, M. D.,
Professor of Medicine, University of Pennsylvania; Physician to the Hospital of the University of Pennsylvania; to the Philadelphia Hospital; Fellow of the College of Physicians of Philadelphia; Member of the Association of American Physicians, etc.

STOCKMAN, RALPH, M. D., F. R. C. P. EDIN.,
Regius Professor of Materia Medica and Therapeutics in the University of Glasgow.

WOOD, HORATIO C., M. D., LL. D.,
Professor of Materia Medica, Pharmacy, and General Therapeutics, and Clinical Professor of Diseases of the Nervous System in the University of Pennsylvania.

YEO, I. BURNEY, M. D., F. R. C. P.,
Professor Emeritus of Medicine and Consulting Physician to King's College Hospital.

GENERAL THERAPEUTIC CONSIDERATIONS.

By HORATIO C. WOOD, M. D., LL.D.

I HAVE found it somewhat difficult to decide the exact scope proper for a chapter which is to serve as the introduction to an elaborate encyclopædic work upon the Art of Treating Disease; but it has seemed to me that the questions which may with propriety be considered in such an introduction are—first, the different principles which underlie the modern Methods of Therapeutics, including a discussion of the way in which physicians have discovered the facts upon which these principles are based; second, Dosage; that is, the question of the amount of the remedies to be given, including the relative effects upon the human system of the same medicine in different doses, and the influences of idiosyncrasies or personal peculiarities, as well as of age, of sex, of habits of life, and other similar agencies, upon the action of medicine in various diseases; third, Rules for the Combination of Drugs which should govern the physician in combining medicines into prescriptions.

THERAPEUTIC METHODS.

There appear to my thought to be only four possible methods of Therapeutics: 1st, Empiricism; 2d, Treatment by some alleged or true Law of Symptoms; 3d, Scientific Therapeutics; 4th, A combination of one or more of these three plans.

Empiricism.—The primeval method of treating disease was that which we now know by the name of Empiricism—a method that may be defined as the using of a certain remedy in a certain disease because it has seemed to do good in similar cases. From time to time, led by chance, by fanciful suggestions, by mental influences unrecognized by their subjects, men have given remedies innumerable and most diverse to persons suffering from disease, and when recovery has occurred it has been generally attributed to the remedy administered last. No substance so vile and disgusting, no procedure so violent and injurious, that it has not been empirically employed and its great value affirmed and reaffirmed time and again. It is true that careful observations repeated on many individuals may at last give a basis of prac-

tical truth and success to empirical treatment, but such method must remain, even after centuries of study, uncertain and unscientific.

Therapeutic Symptomatic Laws.—The constitution of the human mind naturally revolts against such unreasoning action as that of pure empiricism, and consequently from time to time, even in very early ages, alleged general therapeutic laws or theories have been promulgated. When it has so happened that such theory has led to practical success in some directions, the minds of men have often been subjugated by the appearance of truth. This is the explanation of the sway of the old doctrine of signatures, which taught that a remedy affects that organ which it resembles in appearance. Thus, the color of rhubarb led to its use in constipation, whilst that of aloes induced men to administer it in diseases of the liver. In either case the patient was often benefited, and the truth of the alleged law was proved at least to the satisfaction of its votaries.

Homœopathy.—Of the various mediæval dreams which led men astray, there is only one whose survival challenges our attention at the present time. This is the so-called Homœopathy, or Hahnemannism.[1]

[1] The question as to the causes of the survival of homœopathy is one of great interest. I believe the first successes of the practice were really due to the fact that the regular physicians of the day did much more harm than good, whilst the homœopathic practitioner, giving only infinitesimal doses, and thereby practically leaving the case alone, allowed Nature full scope. This explanation, however, does not apply to the present time. It seems to be true that homœopathy is everywhere now on the decline except in the United States, as is shown by the following statistics, which are taken from homœopathic sources, and are as accurate as can be obtained:

According to the *British, Colonial, and Continental Homœopathic Medical Directory*, published in London, there were in Great Britain and Ireland, in 1875, 269 homœopathic practitioners; in 1880, 275; in 1883, 260; in 1889, 256; in 1898, 203. It must be remembered that these figures contain a number of names which, according to the editors themselves, are doubtful. Thus, in 1898, there were only 144 practitioners vouched for by the editors. It will be seen at once that not only are there comparatively few homœopathic practitioners in Great Britain and Ireland, but that, notwithstanding the very great increase in the general population and in the regular profession of medicine, there has been in twenty-five years an absolute decrease of 25 per cent. in the number of homœopathic practitioners.

Germany was the birthplace of Hahnemannism; but, according to the *Directory*, already quoted, in 1898, in the whole centre of Europe, comprised of Germany and Austria-Hungary, there were only 285 practitioners of homœopathy, the statistics for the rest of Europe being; Belgium, 43; Denmark, 7; France, 218; Holland, 9; Italy, 68; Portugal, 3; Russia, 68; Spain, 126; Sweden, 2; Switzerland, 21; making a total of 1038 homœopaths in Europe, including the British Isles. This is a population of 360,000,000—about three homœopathic practitioners to each million of people. At this rate there would be about 180 homœopathic doctors in the United States. It is very interesting to note that the largest proportion of homœopathic practitioners on the continent of Europe is to be found in Spain, the one country where the general level of education is the lowest. Certainly a system of practice which in a long series of years has attained no greater result than that just summarized, and the number of whose votaries is steadily decreasing, cannot be said to be on an ascending plane.

In America, Hahnemannism is probably holding its own; the reasons for the differ-

The essential doctrines of Hahnemann were originally three. The first of these taught that chronic disease is the result of a general poisoning of the system by a humor, which when it finds its way to the surface causes the itch. Microscopic investigation and the discovery of the itch insect long since gave a quietus to this theory. The second doctrine of homœopathy is that of so-called infinitesimal doses. This doctrine is not a simple affirmation of what every one knows to be true—namely, that certain substances are so active in their relations with the human organism that the least particle of them impresses that organism ; nor is it a statement that all or any drugs in minute quantities exert an influence antagonistic to the effect which they produce when in large quantity.[1] The infinitesimal-dose theory, as propounded by Hahne-

ence in the two continents are probably multiple. In America individualism runs wildest riot; irregularities of all kinds in religion, philanthropy, and medicine flourish. More potent in promoting Hahnemannism in America, however, than the peculiarities of the people are the deficiencies of the regular profession, which grow out of the lack of legal control over entrance into medical practice: most potent of all factors, however, is the notorious fact that the American homœopath does not practise homœopathy—a fact which our readers may find abundantly proven, not only by the testimony of regular physicians who have watched the practice of homœopaths, but also by the resolution passed in 1878 by the New York Homœopathic Association, affirming, *inter alia*, "We shall exercise and defend the inviolable right of every educated physician to make use of any established principle in medical science, or any therapeutical fact founded on experiments and verified by experience, so far as in his individual judgment they shall tend to promote the welfare of those under his professional care;" and finally by the statements made during the last two or three years by prominent members of the New York Homœopathic Medical Society, who have publicly and repeatedly affirmed in the columns of the *New York Medical Times* that there are practically no homœopathic practitioners, and who, when contradicted, have proven that their contradictors themselves do not adhere to their professed belief.

Homœopathy has, in fact, practically ceased to exist. Certain practitioners of medicine, however, avail themselves of the value of the name as a trade-mark in order to deceive the public and obtain an advantage over their rivals. The time has, in my opinion, come when the regular physicians should no longer, by refusing to consult with homœopathic practitioners, recognize their separate existence. If such a practitioner desires a consultation, he in so doing publicly states that he is on the same platform as the man whom he wishes to consult with; and if consultations between homœopaths, so called, and regular physicians became frequent, in a short time it would be impossible longer to deceive the public. Moreover, the habit of truth-telling would have a very palpable effect upon the homœopathic doctors themselves. Self-respect would soon lead them to tell the truth at all times. In my opinion, the regular profession not only has it in its power, but owes it as a duty to itself and to the public, to announce once for all that homœopathy having ceased to exist, and there being no class of medical practitioners whose practice is based "upon exclusive dogma, the rejection of the accumulated experience of the profession, and of the aids actually furnished by anatomy, physiology, pathology, and organic chemistry," therefore that every physician is at liberty to consult with whomsoever he pleases. By doing this the American Medical Association and other similar representative bodies would simply leave it to the individual doctors to consult when they wished to, but would not take away the right of any man to refuse consultation with an individual on the ground that he was a hypocrite or otherwise immoral.

[1] For discussion of this doctrine in detail, see "Dosage."

mann, does inculcate that a substance like chalk, which is in large doses inert, becomes, under the influence of trituration and dilution, possessed of intensely active properties, as though there were liberated from it a spirit of healing which had been imprisoned in its material grossness. More than this, Hahnemann taught that it was possible by the mere violence of the trituration to potentize almost to infinity. In his *Lesser Writings* he says: "If we wish, for example, to attenuate a drop of the juice of sundew to the thirtieth degree, but shake each of the bottles with twenty or more succussions from a powerful arm in the hand of which the bottle is held,—in that case this medicine which I have discovered, the specific remedy for the frightful epidemic, whooping cough of children, will have become so powerful in the fifteenth attenuation (spiritualized) that a drop of it given in a teaspoonful of water would endanger the life of such child; whereas, if each dilution bottle were shaken but twice (with two strokes of the arm), and prepared in this manner up to the thirtieth attenuation, a sugar globule, the size of a poppy-seed, moistened with the last attenuation, cures this terrible disease (whooping cough) with this single dose, without endangering the health of the child in the slightest degree." In other words, Hahnemann taught that the activity of a medicine depends upon the number of times it had been shaken, and that medical inertness by excessive shaking may become converted into almightiness. Remembering the numbers of the followers of Hahnemann, surely the bitterness of Carlyle, when he says, "Where ten men are gathered together there are nine fools," seems justified. Certainly Hahnemann should rank with the greatest of Indian "medicine men," who, by incantations, exorcise the evil spirits of disease.

It is the third doctrine of Hahnemann which has been and still is the rallying-point of his followers, and which is claimed to be the fundamental truth of his teachings; this is the so-called law of *similia similibus curantur*, in accordance with which a symptom produced by a disease is to be cured by a small dose of a remedy which, when given freely to a healthy man, will cause the same symptom. Strange, is it not, that this alleged law, which has made immortal the name of Hahnemann, was not originally framed by him, but is plainly stated in the works of that really great man—Hippocrates? For two thousand three hundred years this generalization has survived; it must possess some peculiar vitality, some measure of truth, and I myself believe that as a rule of practice it will at times lead to a good result. As illustrating the subject let me suppose a case of vomiting. Ipecacuanha when given in large doses will cause vomiting, but under certain circumstances when administered in minute quantity it will relieve vomiting. Witnessing such administration and such triumph, the bystander cries, "Great is *similia similibus curantur*, and Hahnemann is its prophet!"

But in a second case the vomiting may be increased by ipecacuanha and be relieved by opium, which does not vomit when given to the normal man in large doses, but makes him insusceptible to the action of emetics. Now the upholder of the doctrine of *dissimilia dissimilibus curantur* cries, "Behold, I have the truth: the remedy which produces the opposite to the symptom is the remedy to relieve the symptom."

It is plain that neither in homœopathy nor in allopathy, neither in the doctrine of similars nor in the doctrine of dissimilars, is there the whole truth. A law of nature has no exception, and if exceptions be found to an alleged law, it is plain that the law is only an allegation and not a reality. If we were to find that at times weight disappears, that objects not under the influence of some opposing force or resistance fail to fall to the earth, then we would know that the Newtonian generalization of the attraction of gravity was not a law of nature. Neither allopathic nor homœopathic doctrines are laws; they are mere expressions of coincidences, each of them base coin gilded with just sufficient of truth to pass current with the ignorant and unwary. Symptoms are the mere surface play of disease, marking only with great uncertainty the currents, whirlpools, and rocks that lie hidden far underneath. Symptoms apparently the same may be the outcome of entirely different bodily conditions. Any system of treatment based directly and immediately upon symptoms must be untrue. It is not possible to find any therapeutic law which shall directly relate symptoms to remedies, and enable the practitioner in ease and ignorance to combat disease.

Scientific Method.—The third possible method of treating disease may well be spoken of as the scientific method. In a few words it may be described as being based upon a knowledge of what it is necessary to do in disease; an acquaintance with the power of the forces at hand; and an application, by the ordinary processes of reasoning, of such forces to the needs of the occasion. Unfortunately, we are at present unable thoroughly to carry out these scientific methods in therapeutics, because our knowledge of the disease-processes and our knowledge of the forces at command are each imperfect. Sometimes it may be the fault of the therapeutist, but more often I believe that the difficulty lies with the pathologist and the student of the natural history of the disease. We cannot explain how salicylic acid does good in rheumatism or how mercury does good in syphilis, because we have no knowledge of the essential nature of rheumatism or of syphilis. Every advance of pathology is rapidly followed by a corresponding advance in therapeutics. The powers of quinine in malaria were recognized many years ago by the therapeutist, but not until the pathologist discovered that malarial disease is due to the presence of an organism could the therapeutist know that quinine cures malaria by killing this organism. The discoverers

of the influence of bacteria upon the human organization were followed almost at once by therapeutists who pointed out the brilliant results of disinfection and of antisepsis.

In any attempt at the creation of a scientific therapeutic system the foundations must first be laid by an elaborate, exhaustive study of the natural history of disease when left to itself. For the purposes of discussion, and indeed of practical therapeutics, this study may be considered under four headings: first, the cause of the disease under study; second, the course and the result of the disease; third, how in fatal cases the result is brought about; fourth, the basal conditions which underlie the symptoms of the disease.

Indication.—Before, however, taking up these points seriatim, and showing their relations to the treatment of individual cases, it is necessary to define one term which is much employed by writers on therapeusis. The term "indication" is used by the therapeutist as equivalent to "the pointing of Nature for relief." Thus, a broken bone—that is, the removal of the internal support of the limb—indicates the use of splints, or, in other words, of external support; and constipation, or retention of fæces, indicates the use of a purgative which shall cause expulsion of the retained material. These are very simple examples, but in many cases the indications are discovered with much more difficulty, and the practical success of the physician will often depend upon his skill in reading them. Not rarely the indication is not for a single remedy, but for several, which by acting together will produce a combined result not obtainable through the action of either of them alone.

Cause.—In studying the cause of an existing disorder for therapeutic purposes, it is first necessary to decide whether such cause has already ceased to act, or whether it is still existent and persistent in its influence. When the cause has been a fleeting one, no indications exist in regard to it; when the cause persists, however, the chief indication is for the removal of the cause. Very often we have no power, especially in acute disease, to fulfil this indication; but when we can accomplish the removal of the cause, then are we most successful as therapeutists.

Chronic diseases are frequently produced by improper habits of life, and the alteration of such habits is most urgently demanded. Alcoholism and chronic lead-poisoning are further instances of affections in which the immediate removal of the cause—first, by the prevention of the absorption into the body of more of the poison; second, by the elimination from the body of all that therein exists—is most imperative. Again, when we disinfect a wound, destroy a malarial organism by quinine, or kill a tape-worm by kooso we are carrying out the indication for the removal of the cause.

Course.—To the therapeutist a knowledge of the course of any disease, whether its continuance is definite or indefinite, whether its tendencies are toward health or toward death, is vital. Very rarely can an acute disease which has a definite course be arrested or put aside by any therapeutic measure; and in such cases there is a strong negative indication for the withholding of any attempt to arrest the disease. Active interference will, under such circumstances, usually do harm. This is especially true when the natural tendency of the disease is toward recovery. When, however, the tendency of the disorder is very strongly toward death, the arrest, if possible, must be had at all hazards. Thus, in a case of malignant ulcer or of hospital gangrene or of cancer the overwhelming indication is to remove the affected part, even if it can be done only at a considerable risk.

Method of Death.—When, especially in an acute disease, a fatal result sometimes occurs, it is a matter of the gravest importance to decide the way in which such result is produced, so that if possible it may be warded off. Thus, in typhoid fever we know that death is usually produced by exhaustion; hence the indication throughout an attack of typhoid fever is to combat exhaustion by absolute rest, by proper feeding, and by moderate stimulation. We know also that the fatal result may be produced by a local ulceration, and be greatly aided by excessive diarrhœa; hence the indication to soothe irritation and arrest excessive secretion by careful regulation of the diet and by the use of properly-selected local sedatives. Again, in typhoid fever the exhaustion may be greatly increased by changes in the tissues produced by an excessively high temperature; hence the indication for the use of antipyretics and external cold, it being remembered that these agents are not to be employed in a routine manner in all stages or even in every case of the disease, but are to be used simply to meet one indication as it arises; that is, to keep down the excessive heat.

To take a second example of the way in which indications are to be drawn from studies of disease: during the forming stage of a sthenic pneumonia there is a local vaso-motor paralysis in the affected lung, with a great excess of blood in the part, and the indication is, if possible, to withdraw blood from the lung. For this purpose large doses of a remedy which will quiet the excited heart-action, and at the same time paralyze the general vaso-motor system, are indicated. Such a drug is found in veratrum viride. Under its influence the heart-force is greatly reduced, and, what is more important, the widespread dilatation of the vessels throughout the body equalizes the vaso-motor condition everywhere and causes the withdrawal of the blood from the congested lung. It must be remembered that the abdominal blood-vessels are so large that when thoroughly relaxed they are capable of holding the blood of the body, and when this relaxation is obtained in a forming pneumonia

by the use of a drug the patient is, as it were, bled into his own vessels. The result obtained is similar to that formerly reached by venesection, without the exhaustion which venesection produced. On the other hand, if consolidation has occurred in a pneumonia, one grave danger is failure of power in the right side of the heart. Possibly one-sixth or one-fourth of the blood-channels through the lungs are practically closed, and the work required of the right heart, in order that the blood may be forced through the narrowed space, is much beyond the norm; this, too, at a time when the heart is suffering from the exhaustion of a severe general illness. Under these circumstances a cardiac depressant would immensely increase the danger. Now the indication is for a cardiac stimulant—a drug which, like digitalis, shall quiet the heart (irritated by these excessive calls upon it), lengthen the diastole, so that the ventricle can thoroughly fill itself with blood, and finally so strengthen the systole as to enable the heart to force the blood through the narrowed channels in the lungs.

Basal Conditions.—In carrying out the indications which have been spoken of in the last paragraph the therapeutist is simply affording relief by the treatment of certain symptoms whose tendency it is to do harm. More important than these in most cases are those therapeutic measures which arise out of the correct understanding of the basal conditions of body which underlie the symptoms. The proper recognition of such conditions is, in individual cases, of the gravest importance and often of great difficulty. The real nature of the bodily state having been made out, it is generally easy to direct medication for relief. Thus, in any given case of heart disease the diagnostic problem for the purpose of treatment is not as to whether this valve or that valve is diseased, or whether the heart-muscle is weaker or stronger than in health, but whether the normal relation between the heart-muscle and the work required of the organ is preserved. Thus, in a suppositious case the leakage in the valves may necessitate the putting out by the heart-muscle of twice the normal amount of force in order to maintain the balance of the circulation, and yet the heart-muscle has only been increased in its power one-half. Under these circumstances, although there is an absolute hypertrophy of the cardiac muscle, the basal condition is one of cardiac weakness, because the increase of heart-power has not kept pace with the increase of heart-work. The absolute cardiac hypertrophy is in fact a relative cardiac weakness, and the indication is for a cardiac tonic and stimulant—an indication to be met by the use of digitalis or of some other similar drug.

To illustrate further the relations between basal conditions and treatment, let us consider cases in which the functional activity of an important organ is abated. Under these circumstances the diagnos-

tician may find that all the nutritive supplies of the organ are less than normal. This being so, the indication is for a stimulant to nutritive activity. On the other hand, the diagnostician may find that functional activity is abated because the nutritive processes are in excessive activity, and then remedies which will soothe and quiet nutrition are demanded.

In interpreting any individual case of disease it must be borne in mind that similar symptoms are produced by opposite basal conditions. Thus, purging may be the outcome of intestinal paralysis or of intestinal irritation, while constipation may result from intestinal irritation or intestinal paralysis. An apoplectic unconsciousness may be due to arrest of circulation in the brain or to a sudden increase of blood in the brain. A furious delirium may result from exhaustion or may be a manifestation of a violent irritation of the cerebral cortex; and in like manner a convulsion may be produced by lack of power of the nerve-centres or may have its origin in centric irritation. If the temperature of the brain be lowered below the norm, as in heat-exhaustion, unconsciousness with muttering delirium is caused; whilst the excessive heating of the brain which occurs in thermic fever also may betray itself by unconsciousness and muttering delirium.

In an individual case of disease the nature of the condition is to be recognized, not so much by a survey of the chief symptoms as by the careful consideration of these symptoms in connection with others which may seem of minor importance to the inexperienced, but which really mark the direction which the current takes. To discuss here in detail the subject of indications drawn from studies of the fundamental states in individual diseases would be out of place, but there are two conditions so similar in their manifestations, and so often mistaken, that it seems proper to say a word concerning them. These states are especially important, since they may exist in a single organ or in the whole body—*i. e.* they may be local or general. I refer to exhaustion and depression. In exhaustion power is wanting; in depression the power is preserved, but the system or organ is prevented from exercising it by the presence of some paralyzing agent. The strong man dying of starvation and the strong man tied with bonds illustrate the two conditions. In exhaustion help can only come through food and rest, and medicines are of value solely as they enable the system to get the rest or to appropriate the food. In a case of depression a stimulant is only useful when it affects digestion and increases the assimilation of food, or when it aids in keeping some vital function going, as that of the heart, and so helps to maintain life until recuperation can occur. In depression food and rest are of subordinate importance, and it may well be that food shall really do harm, because the person is unable to digest it. The indication is for a stimulant, for some medical agent that will overcome the action of the depressing poison.

Remedial Forces.—When the therapeutist has acquired the knowledge of the pointings of nature for relief in disease, he must next consider the forces which are at hand for the meeting of these indications. Prominent amongst these various curative forces are those embodied in medicinal substances, so that a study of the action of drugs upon the human organism in health and in disease is of the first importance. Such study, so far as the symptoms produced by drugs are concerned, may be made by administering to healthy men and women, in various but safe doses, the drugs which are to be tested, and by carefully observing the phenomena produced in accidental or intentional poisoning. In this way, however, we can only arrive at a knowledge of the symptoms produced by the medicinal agent, but when it comes to explaining these symptoms and to determining the exact method in which the drug acts, experiments are essential. In any science which is to be advanced by experiment the would-be investigator must have the power of varying the conditions of the experiments; otherwise no new points can be elicited. The physiologist cannot use man for the purpose of experiment; he must have an individual unit that can be sacrificed to the needs of science for the benefit of the human race. It is not only possible, but morally justifiable, to make these experiments upon the lower animals. As exemplifying the necessity of these experiments, let us suppose that the drug A slows the pulse. It may do so either by stimulating the inhibitory nerve or by a direct influence upon the heart-muscle or its contained ganglia. If we are confined to observations upon man, we can never determine in what way the drug slows the pulse. If, however, we are allowed to divide the pneumogastric or inhibitory nerves in the animal, the point can at once be decided. Or suppose the drug B causes convulsions. Are these convulsions spinal or cerebral? With man we can only infer; in the animal we can divide the spinal cord and give the drug, when, if the convulsions be cerebral, they will be arrested at the point of section of the cord, but if they be spinal they will occur throughout the entire body.

The value of direct studies upon the lower animals has been denied on the ground that drugs act differently upon man and the lower animals. Physically, man is certainly nothing more than a highly organized animal, in which nervous development and specialization have been carried to the highest extent; he still remains an animal, and it is inconceivable that his relations with the forces of the universe are altogether apart and different from those of other animals. Nevertheless, it is true that many drugs do affect men differently from the way in which they act upon the lower animals. It is, however, true that there are differences among the lower animals in their relations to drug-forces. Moreover, it does not seem possible that

these drug-forces are isolated from the rest of Nature in being the subjects of caprice rather than of law, and it becomes the scientific therapeutist not to deny, but to seek out—not to say it is impossible to understand the relations of drugs to man and the lower animals, but to attempt to discover the laws which govern the apparent variations.

Enough of these laws are in sight to guide us in most cases. The first of these laws is that which I would call the *Law of Differentiation*—a law which is readily explained by stating that when an anatomical system is similar in its functions in different animals it is similar in its relations to drugs, but when its functions are differentiated, so also are its drug relations. Thus, in some animals the digestive system is arranged for the digestion of vegetable food, in others for the assimilation of animal matters, and in man for the needs of an omnivore. Under such circumstances we see variations of the digestive system in its relations to drugs corresponding to the variations in structure and function. We can understand why elaterium, although it purges a man, fails to purge a dog. For this reason the greatest caution must be practised in using experiments made with drugs upon the digestive apparatus of the lower animals for the interpretation of their effects in man.

On the other hand, the function of the circulatory system is similar throughout Mammalia; and it is well known that veratrum viride, digitalis, and other drugs, which act especially upon the circulatory system, act upon the lower animals as they do upon man, function and drug relations in the circulatory system being alike uniform throughout all forms of animal life.

The second *law* is that of *Development*, by virtue of which when any anatomical system becomes more differentiated and developed it becomes more susceptible to the action of drug-forces. An exemplification of this law may be found in the action of opium throughout the animal kingdom. As is well known, this drug acts upon the frog almost as does strychnine, causing great spinal excitement and general tetanus, whilst in man its influence is especially noticeable upon the brain, causing sleep or stupor. This difference of action is often quoted as showing the hopelessness of the attempt to reason from the lower animals to man. If, however, the attention be directed, not to the two or three experiments at the extreme ends of vertebrate development, but to studies made upon the whole range of animal life, it will be found that there is a regular gradation in the symptoms, caused by opium, the spinal manifestations becoming less pronounced and the cerebral symptoms becoming more marked as the scale of animal life is ascended. In the frog the spinal system seems to be proportionately more active than in almost any

other animal; hence it is especially sensitive to the influence of opium. In the horse the brain and spinal cord are equally active and equally sensitive to the opium, and consequently the spinal and cerebral manifestations are about equal in opium-poisoning. In the dog the brain is more highly developed, and the cerebral symptoms of the poisoning begin to be more apparent; whilst in man the over-development of the brain makes it so susceptible to the drug that the cerebral symptoms surpass and overshadow the spinal phenomena.

The third *law* is that of *Acquired Habits.* It is with much reserve that I venture to suggest the correctness of the theory involved in this law. The object is to account for those cases in which certain drugs, especially certain narcotic drugs, have lost their influence upon various species of animals. It is well known that the animal system becomes accustomed to the habitual use of vegetable narcotics, so that doses which in the normal individual produce severe symptoms can be taken with impunity. My present thought is that probably this temporary habitual influence has been acquired by successive generations until it has been permanently stamped upon the species, so that the drug has finally lost its influence not only upon the animal, but also upon its offspring. It is alleged that the Virginia deer can feed upon the tobacco-plant, and I have seen stated by apparently reliable authority that certain monkeys inhabiting the regions where the *Strychnos nux-vomica* grows are entirely insensitive to the influence of strychnine. I have frequently seen our domestic goats, haunting the purlieus of cities, eat with absolute impunity the stramonium-plant.

In stating these generalizations, which I have ventured to call laws, it is not presumed that they cover the whole field or enable us to explain every case of variation in the effects of remedies on various individuals. Whatever contradictions may appear to arise in the results obtained by experiments, it is certain that animal experimentation affords our only possible means of investigating the physiological action of medicines. Whatever difficulties may beset this path, it is the only one which can lead us to a scientific therapeusis. In following it we must acknowledge, first, as a fundamental axiom, that no amount of experimentation can overthrow a clinical fact, although when a contradiction between experimental and bedside observation seems to arise, such contradiction challenges the correctness of the alleged clinical and experimental facts alike, and should lead to a careful re-examination. It was discovered by Traube that digitalis increases the blood-pressure in the lower animals, which led to a doubt of the correctness of the then general belief that digitalis acts upon man as a cardiac sedative, and finally to the recognition of the falsity of the clinical observation upon which such belief was founded. The field of vision of the experimenter must not be confined to one species or to one set

of animals, but the whole series of animal life must in detail be passed in review; and I believe that almost invariably a complete study of the clinical and experimental evidence will reveal a beautiful concord—that concord between experimental and practical medicine which so often fails to appear, simply because we cannot fit together the fragments of truth in our possession.

In the last twenty years therapeutics has grown enormously toward scientific accuracy and in scientific methods, and each year witnesses marked progress. Nevertheless, we are still hampered by our ignorance—an ignorance which, as has already been stated, is more often in the region of pathology than that of therapeusis—and we are therefore forced at present to mingle science and empiricism; so that the best therapeutics of the day, the therapeutics which is to be inculcated in the present System, is a *mixture of science and empiricism.*

Dosage.

By the term *dose* is meant the amount of a medicine which it is safe or proper to administer to a human being. The doses which are given in textbooks on therapeutics of necessity differ considerably from those used in practical medicine. It is, indeed, not intended that these given doses should be considered as fixed quantities, but as average amounts, which are to be departed from to suit the needs of the individual case. The maximum dose of the active remedies, as given by the textbook, is or ought to be the amount which will produce slight but distinct symptoms in a normal individual: such dose is sometimes termed the Physiological Dose. Doses are sometimes spoken of as the Single, the Continuous, and the Daily Dose. The Single Dose is that which it is proper to administer at one time, without expectation of repetition. It is usually given for the purpose of producing an immediate effect, as in the administration of a purgative. The Continuous Dose is that which it is proper to administer when the remedy is to be repeated at shorter or longer intervals for the purpose of maintaining an impression upon the system. The whole amount of the added continuous doses, as given in the twenty-four hours, is spoken of as the Daily Dose. In administering remedies to make a prolonged impression it must be remembered that the effects, and especially the length of time which each dose acts, vary greatly according to the nature of the remedy, and especially according to its relations with the excretive glands. The vegetable alkaloids are usually rapidly absorbed and rapidly eliminated or destroyed, so that each dose acts promptly and there is no accumulation of the drug in the system. On the other hand, those vegetable remedies which are dependent for their activity upon glucosides commonly yield their active principles slowly to absorption; but when these principles are once taken into the body they are eliminated with

great slowness, hence the liability of remedies of this class to have the so-called cumulative action—*i. e.* to exert, after long continuous use without much apparent effect, a sudden overwhelming influence. As an example of a substance possessing this cumulative action may be mentioned digitalis. It has been repeatedly denied of late years that this drug ever acts in this way, but I know from personal experience that it does do so. Thus, in a case in which it had been long administered in hopes of aiding in the absorption of a pleuritic effusion no effects were apparent until a certain Sunday, when the pulse fell from about 100 to 85. Although the drug was immediately withdrawn, the progressive fall of the pulse-rate continued, so that by Wednesday the heart beat only forty times a minute, and not until Friday did the pulse-rate begin to rise toward the normal. The cumulative action of digitalis is especially liable to occur when the drug fails to increase the activity of the kidneys; that is, when it fails to be eliminated. A sudden cumulative action of digitalis is sometimes produced by a sudden absorption of it from the tissues where it has been stored. Thus, I have known cases in which digitalis had been given for a length of time for the relief of heart symptoms, in which "tapping" was finally resorted to on account of the excessive ascites, with the result that a day or two after the tapping there was an explosion of digitalis-poisoning. The explanation of this is very simple: the withdrawal of the pressure upon the outside of the abdominal vessels caused in them general relaxation, which relaxation in turn lowered the general arterial pressure throughout the whole system, and thereby favored absorption of the serum lying in the various tissues of the body. This serous dropsical fluid was, however, saturated with digitalis that had been gradually stored up in it, so that with its absorption there was a sudden pouring of digitalis into the blood, and as a necessary result an excessive action of digitalis; for it must be remembered that it is not the drug which is in the tissues of the body, but the drug which is in the blood-vessels, that influences the heart and nervous system.

Mineral substances are more apt to accumulate in the body than are those belonging to the vegetable kingdom. Arsenic, mercury, lead, and various other minerals are well known to be deposited in the tissues. Other mineral substances which do not yield insoluble compounds in the body, and are not therefore deposited in bone, muscle, or nerve-centres, nevertheless may accumulate in the various liquids and tissues, although after the cessation of their administration they are more or less slowly removed. Thus, when the bromides are given continuously they gradually saturate the system, and produce the so-called "bromism," a condition which rapidly disappears on abstinence from the remedy, because the loose, soluble bromide compound is rapidly taken up by the blood and thrown off by the kidneys. The effects of lead-

poisoning, on the other hand, are permanent, because the insoluble lead compound remains in the tissues.

A knowledge of the relations between absorption and elimination in affecting the effects of remedies is of the gravest importance in practical medicine, and it is extraordinary that these relations are so often lost sight of in the administration of drugs. The generalization which naturally follows immediately upon their consideration is that not only the size, but especially the frequency, of the dose must be adapted to the usual rate of absorption and elimination of each individual drug, as well as to the effects desired upon the system. The dose of a very fugacious agent must be repeated at brief intervals, in order to have any steadiness of action. Yet how often is the whole matter forgotten! As an every-day example take an ordinary cold or mild bronchitis. Certainly in this affection a steady impression is desirable. Nevertheless, for the relief of a cough hydrocyanic acid is often given in a mixture every three or four hours. The influence of this acid is so fugacious that the symptoms caused by a toxic dose usually disappear within an hour. The ordinary dose of hydrocyanic acid is so small as not to have any perceptible physiological action. If a very powerful toxic influence is over in an hour, how long will an imperceptible, intangible, and probably non-existing influence last? It is hardly necessary to point out in more detail the utter folly of giving the acid in the way commonly indulged in. The matter is much more serious in the employment of remedies which have more positive influence upon the system than has hydrocyanic acid in therapeutic doses. The action of an ammoniacal salt is almost as fugacious as that of hydrocyanic acid, yet how often are ammoniacal remedies given in large doses at intervals of three, four, or even five hours!

This habit of giving at short intervals powerful remedies whose influence is short lived I have sometimes in my lectures called the "*kangaroo*" *method*, the name being suggested by the thought that such treatment consists in a series of great "hops"—a stimulation or other strong medicinal influence for an hour, an unaffected condition for an hour or two, another brief period of medicinal stimulation or depression, as the case may be, a relapse, and so on.

When absorption and elimination of a drug take place slowly, the intervals between administration may well be lengthened. Thus, it is rarely necessary to give digitalis oftener than once in four hours. Again, when the full influence of the drug is only reached by bringing about an accumulation of it in the system, the intervals may be very long. As an example a case of epilepsy may be taken in which mild bromism has been produced. In such a case, from the bromide pool, to use a metaphor, in the system there is a constant slight leakage throughout the whole twenty-four hours by elimination, but the loss from the pool

can as well be made up by additions by two doses in the twenty-four hours as by doses at shorter intervals, because the single dose is so small in proportion to the mass in the system that its immediate influence in raising the surface of the pool is not perceptible. The constant taking of medicine is to most people very disagreeable, and in epilepsy it is wisest to avoid the annoyance of the frequent repetition of the dose.

During the last few years an attempt has been made to establish a therapeutic law or guiding principle, which, although not identical with the law of "similars," as inculcated by Hahnemann, has close relation with it. This alleged law may be formulated as follows: All medicinal substances, when given in small doses, produce results precisely opposite to those which they cause when administered in large doses. In my opinion, the only novelty that there is about this allegation is in the absoluteness and dogmatism with which it has been made. It has been known from time immemorial that the symptoms produced by small doses of *certain* drugs, especially by those drugs which we consider stimulants, are the reverse of the symptoms caused by large doses of the same drugs. It cannot be denied that ammonia, alcohol, and ether excite cardiac action—*i. e.* increase functional activity—when in moderate amount, although when in large quantities they arrest the heart in diastole—*i. e.* paralyze functional activity. On the other hand, there is not the shadow of proof as yet that *all* drugs act differently in large and small doses. Aconite, so far as we know, depresses the heart-muscle whether in small or large amount, whilst digitalis augments the functional power of the heart-muscle until at last cardiac arrest takes place in spasm. As did Hahnemann, so here also does it seem to me that these new therapeutic generalizers have mistaken a partial truth for a whole truth, and made a generalization based upon symptoms instead of upon bodily conditions. There must be some differences between the action of a remedy which, like ammonia, first increases and then decreases functional activity, and one which, like digitalis, creates a spasm which abides to death; and it may well be that certain forms of functional excitement naturally end in paralysis without there being change of kind in the condition of the affected part.

The old doctrine that excess of stimulation ends in arrest of function affords a wiser way of putting the matter than the new method of statement, because what is true of drugs is also true of forces. A moderate heat stimulates activity; an intense heat paralyzes it. A feeble electrical current contracts the muscle; a sufficiently powerful one paralyzes it permanently. It would seem, however, that even this generalization is not correct, for there appear to be stimulants which in excess fail to paralyze.

I do not think it necessary to occupy more space with a discussion of this matter. We are not near enough to the knowledge of the real

methods of action of drugs to make any fundamental deductions; all attempts to build up a system of therapeutics upon such more than doubtful generalization must remain for a long time to come futile. The practical therapeutist must, however, always keep in remembrance the fact that many remedies act differently in different doses, and must accordingly apply his knowledge in treating individual cases of disease. The different actions of different doses are sometimes seemingly antagonistic, but not rarely they are for practical purpose entirely different in kind, having no apparent relations. Thus, as is well known, a small dose of alcohol acts chiefly as a digestant when given with food, enabling the stomach more readily to assimilate; a larger dose of alcohol acts as a general stimulant; an overwhelming dose as a paralyzant both of the nervous and circulatory systems. In the same way, a small dose of quinine may be of service as a stimulant to the stomach and to the general nervous system; in a larger dose the alkaloid is given as an antiperiodic for the purpose of arresting malarial disease, whilst by some therapeutists enormous doses have been administered for the purpose of depressing the circulation and the general system, and thereby obtaining relief in inflammatory conditions.

Physical State of Patient.

The physical states of patients, as well as their environments, so greatly influence both the effects of medicine and the size of the dose proper to be employed that it seems necessary here to devote some pages to their consideration. For the purposes of discussion these general conditions are best arranged under the headings: Age and Sex; Time and Method of Administration; Emotion; Temperament; Idiosyncrasies; Climate and Habits of Life; Disease.

Age and Sex.—For the purposes of physiological experimentation, especially when it is intended to determine the minimum fatal dose of a remedy, great accuracy of dosage is required. It is evident that in an animal weighing one hundred pounds the amount of blood, and consequently the dilution of a given dose of a drug after absorption, must be greatly in excess of what it is in an animal weighing ten pounds. Domestic animals, of the same breed, often differ extraordinarily in their size. For these and other similar reasons the physiologist always gives the dose of a drug as so much per pound.

In human medicine we do not expect such extreme accuracy of dosage, and the difference of weight between individuals is not so great. Consequently, the therapeutist very rarely speaks of the dose per pound. At the same time, in the case of extremely small or extremely large persons the dose should be altered from the average standard. The difference between the weight of the child and the adult is very great. Partly from this fact, and partly because some

portions of the organization of the young are more susceptible than they are in adult life, the necessity arises for a very careful adjustment of the dose in the cases of children. The late Professor Clarke proposed a plan according to which the dose is to be graded by the weight of the child. One hundred and fifty pounds was taken as the weight of an average human adult, and in order to obtain the fractional dose this number served for the denominator of a fraction whose numerator corresponded to the weight of the child in avoirdupois pounds. Thus, the formula for a child fifty pounds in weight would be $\frac{50}{150}$ or one-third of the dose for the adult. A theoretic objection to this rule is that though it attempts scientific accuracy, it makes no allowance for the difference in susceptibility in the different anatomical systems in youth and in age. A more important practical difficulty is found in the fact that very frequently the physician does not accurately know the weight of the child. In actual practice the arbitrary rule of Dr. Young is the one which I think is almost universally adopted in this country and in England. According to this rule, the fraction for the child is found by the formula of $\frac{\text{age}}{\text{age} + 12}$. Thus, if a child were four years old, the proper dose would be $\frac{4}{4 + 12} = \frac{1}{4}$th of the adult dose. In the formula of Cowling, still sometimes used, the fraction is, $\frac{\text{age next birthday}}{24}$; according to this, the dose for a child approaching four years of age should be $\frac{4}{24} = \frac{1}{6}$ of the dose of the adult.

It will be seen that these formulas give quite different results. I think that that of Dr. Young is, on the whole, the more accurate, but in applying it the practitioner must remember that it is an arbitrary rule with numerous exceptions. In the case of purgatives the dose should usually exceed that allotted by the Young rule. Thus, for a child four years old a dessertspoonful of castor oil would not be an overdose, whereas the dose should be a teaspoonful according to the rule. On the other hand, with remedies which powerfully affect the nervous system the dose should usually be much below that given by Young. Thus, in a child two years old the fraction by Young's rule would be $\frac{1}{7}$, which would give as the ordinary dose of laudanum 4 drops, an amount certainly dangerous.

As old age is approached the human nervous system usually becomes less sensitive, and hence feels less acutely the effects of narcotics; hence, morphine and similar drugs can be used more freely than during middle life. On the other hand, depressing influences are less stoutly resisted, and hence the use, and especially the doses, of all depressing drugs should be more and more restricted. During pro-

gressive failure of the physical powers stimulants are very well borne, and should be employed more freely than in earlier life.

In regard to the influence of sex upon dosage, it is hardly necessary to point out that woman is not only smaller, but, at least in this country, more sensitive than man, and that therefore the proper doses for her, especially of depressing or perturbating medicines, are smaller than for man; also, that the dominating influence of her sexual life must never be lost sight of. During menstruation it is often well to suspend active medication, and always imperative to avoid disturbing the general system without due cause. During pregnancy emetics are of course strongly contraindicated, as are also remedies which have a distinct tendency either to irritate the kidneys or to depress the vital forces.

Time and Method of Administration.—The time and method of administration of remedies are chiefly of importance, because by a knowledge of these facts we can gain information as to the rate at which the remedies are absorbed and as to the influence which they exert upon the tissues through which they find entrance into the body. As portals for the admission of medicines into the human body physicians have the stomach, the rectum, the lungs, the skin, and the cellular tissues under the skin.

The most general rule for the administration of a medicine is that the drug must be given by the mouth, unless obvious reasons exist for not doing so; so that the dose given in the textbooks is that for use by this entrance.

The solvent powers of the gastric and intestinal juices are so great that few medicinal substances refuse to yield to them.

The form in which the remedy is administered has much to do with the rapidity of its absorption. Usually, but not always, a substance in solution or a soluble preparation is more rapidly taken up in the stomach than an insoluble one. Certain solutions are, however, precipitated by the gastric juices; as examples may be mentioned a number of the soluble salts of iron. If the active principle be in solution, it will commonly be more rapidly absorbed when the stomach is empty than when the viscus has food in it; if, however, the drug must be dissolved in the stomach, it may well happen that absorption takes place best after a meal. Medicines which are locally irritant are best given when the stomach is full, so that they may be diffused through the mass of food, and not come in contact with the mucous membranes in concentrated form. On the other hand, if it be desired to affect the stomach locally, it is better to give the remedy when the viscus is empty. Thus, in chronic inflammation of the stomach nitrate of silver should be administered half an hour before meals; but when, as in epilepsy, the expectation is to affect the general system, the silver salt ought to be

exhibited after meals. When the mucous membrane of the intestines is to be reached, it is commonly better to give the remedy at a time when the natural flow of partly digested food from the stomach into the intestines is in fullest activity. Thus, in gastric irritation the subnitrate of bismuth should be administered half an hour before meals; in intestinal irritation at from one to two hours after meals.

When *rectal injections* are given the fact should be remembered that the general office of the rectum is to throw out rather than to absorb, and that its juices are alkaline in their reaction and have very feeble solvent powers. Medicines are therefore taken up from the rectum with difficulty and great slowness, and when rapidity of effect is desired this channel should not be employed. If it require half an hour for the absorption of a certain alkaloidal salt from the stomach, about fifty minutes should be allowed for absorption from the rectum. It has been the habit of many physicians to make the rectal dose of medicine one-half greater than the dose by the mouth. The chief value of rectal medication is for the purpose of influencing the rectum itself or the neighboring organs. The preparation of the remedy used must be small in bulk and free from irritant properties, otherwise it is rapidly rejected.

When the remedy is suitable and properly prepared for exhibition by *hypodermic injection*, it is absorbed much more rapidly than when given by the stomach. If half an hour be required for the gastric absorption of a medicinal principle, fifteen minutes will probably suffice for absorption through the cellular tissue. The hypodermic dose may be set down as commonly about 20 per cent. less than the stomach dose. This difference arises partly from the greater rapidity of the absorption, but probably also, in part, because alkaloidal salts are to some extent destroyed in the liver, so that only a portion of the remedy reaches the general system after its absorption from the stomach.

There are so many objections to the hypodermic method of medication that it should not be employed unless for obvious reasons. There is always a possible danger of throwing the entire dose into a vein, and consequently into the right side of the heart in a concentrated form. I once injected one-sixth of a grain of morphine into the arm of a woman, who within two minutes fell back unconscious. The jaw dropped, the respiration ceased, and for a time I thought I had killed my patient. Abscesses and ulcerations have resulted from hypodermic injections in innumerable cases; in the great majority, if not in all, of the cases because the syringe or the solution used was not aseptic. A perfectly pure solution may, however, make a long-continuing but non-purulent inflammation. It is essential that the hypodermic solution and the syringe with its needle be thoroughly aseptic. It must also be remembered that the cellular juices are distinctly alkaline, and

that therefore in the use of substances which, like quinine salts, are insoluble in alkaline solutions care must be taken to have the solution distinctly acid: vegetable acids are usually preferable to the mineral acids. Local inflammations are also much less apt to arise if the solutions are thrust boldly and deeply into the part, since when the injection is practised directly under the skin that membrane may be torn from its attachments sufficiently to interfere with its circulation. Distilled—or, better, recently-boiled—water should commonly be used as the basis of a hypodermic solution. Unboiled well, river, or other natural water must never be accepted, but alcohol is in some cases permissible. Thus, we have no concentrated watery preparation of digitalis, and when urgency exists the tincture may be employed. Ten minims of it will usually not cause serious local trouble. Nevertheless, it is only on rare occasions that the physician is justified in using any other drugs than alkaloidal salts hypodermically. Never should an insoluble substance be thrown into the cellular tissue. It is true that insoluble mercurial preparations have been highly recommended for hypodermic use by some European syphilographers, but they should not be tolerated. I have seen death result from the local sloughing produced by calomel injections which had been given with the strictest attention to the minutest rules laid down by the highest European advocates. Corrosive sublimate is the only mercurial preparation that should be given hypodermically.

Endermic Method.—The absorption of drugs through the skin from medicated baths takes place with such slowness and feebleness that we can rarely use baths for the purpose of impressing the general system. When, however, the skin is anointed with a fatty material containing a medicinal substance, absorption to an appreciable extent may occur; hence, inunctions, or rubbing with fatty preparations of active drugs, have been largely practised for the purpose of affecting the whole organism. It is important when inunctions are to be practised that the fatty material chosen be such as is best adapted to the purpose. Four substances are in common use: lanolin, cosmoline, ordinary fats, and more or less impure oleic acid.

Lanolin is chiefly a sebaceous substance, containing a large percentage of insoluble cholesterin; it is a natural fatty material that is thrown out for the purpose of rendering the hair of the animal soft. It is really of the nature of an excretion, which is not meant by nature to be absorbed, but to remain on the surface of the skin as a soothing, non-irritating emollient which shall render the skin and hair more pliable. Whilst, therefore, it is well adapted to be the base of an ointment intended to act locally on the skin, it is not a suitable vehicle when absorption is desired. Cosmoline is a mineral substance, the major part of which is composed of paraffin, which is very insoluble

and probably incapable of absorption. Nevertheless, the more fluid oils which enter into the composition of cosmoline, and which probably are the solvents of the medicinal substances with which cosmoline is impregnated, probably aid the absorption of the drugs into the system, and certainly a cosmoline ointment is capable of impressing the organism. Experience, as well as *a priori* reasoning, indicates, however, that as a vehicle, when absorption is desired, cosmoline is inferior to the natural animal fats. The old objections to these latter substances are their liability to become rancid and the sense of "dirtiness" which attends their use. It is especially on the score of cleanliness that solutions of active principles in fatty acids have been praised under the term of oleates, and it also has been claimed for them that they act more promptly than true ointments. The efficiency of these oleates cannot be gainsaid, but they are more expensive than ointments, and have seemed to me to be more irritating to the skin; for these or other reasons oleates have failed to gain favor and are very little used.

The use of the skin as a portal of entrance to the body is, after all, only rarely proper. Absorption takes place so slowly, and with so much uncertainty, that it is not possible to have any conception whatever of dosage. The only proof in a given case that absorption has taken place is the production of the physiological action of the remedy or the finding of the active principle in the excretions.

Almost the sole advantage attached to the exhibition of medicines by the skin is the avoidance of the local action of the drug used upon the internal organs; but when it is desired to impress the system as rapidly as possible the drug may simultaneously be given by the mouth, by the skin, and by the rectum.

Endermic medication is at present confined almost exclusively to the use of mercurials. In exhibiting these remedies it is essential to bear in mind that they are locally irritant, and that a definite plan of administration must be arranged, so that no one portion of the surface of the body shall have the ointment applied to it two days in succession. It must also be remembered that some portions of the skin absorb much more rapidly than others. The following is a working schedule: Sunday, left arm-pit; Monday, left flank and groin; Tuesday, inside of left thigh; Wednesday, inside of right thigh; Thursday, right flank and groin; Friday, right arm-pit. When inunctions are to be practised twice a day, the backs of the calves of the legs may be interpolated in this schedule.

Inhalations.—The anatomical arrangement of the lungs is such as to offer an enormous amount of surface and a very easy entrance into the absorbents; consequently, these organs afford the most open portal to the system, for entrance through which, however, a substance must be

in the form of gas or vapor. The lungs are not only adapted for rapid absorption, but also for rapid elimination, so that a gas not only enters through them with absolute freedom, but also is thrown out with almost equal rapidity when fresh supplies are no longer furnished. In these facts is to be found the cause of the rapid development and the fugaciousness of surgical anæsthesia.

When it is desirable to impress the system for any length of time substances which are not easily vaporable, and which therefore are not easily eliminated from the lungs, must be employed. It is only in the crises of an acute disease, when an overwhelming, immediate impression is desired, that the physician avails himself of this method of administration.

Atomization, or the pulverization or breaking up into fine spray of water with some substance dissolved in it, is an important medicinal process. It is not, however, well adapted for internal general medication, and is used only in order to obtain a local influence upon the mucous membrane of the air-passages. When it is desired to reach the upper passages, the spray may be a coarse one; but the lungs themselves can be affected only by a very fine spray thrown into them in large volumes during full inspiration.

Habits of Life, including Climate.—Whatever may be our belief in regard to the Darwinian theory of creation, it is certain that the animal system adapts itself within certain limits to its environment, and that, therefore, habits of life have a profound influence upon the whole organism; and, as a further consequence, the relations of drugs to the individual are altered. Hard physical work, habitually kept up for years—especially when, as is generally the case, it is associated with habitual exposure to weather as well as to hardships of greater or less severity—produces a condition of the system in which disturbing influences are little felt until they become excessive in their power. On the other hand, refinement, luxury, and indolence naturally tend to the production of effeminacy and of a peculiar sensitiveness to disturbing agencies. The history of the human race everywhere teaches this lesson, and I am told by experienced veterinarians that it is almost as apparent in the lower animals, so that cart-horses and similar animals of low pedigree often continue to eat their oats whilst surgical operations are being performed on them which would make a thoroughbred racer scream with pain and plunge wildly about.

Any one who has passed through an apprenticeship in the wards of a great city hospital, chiefly given over to the care of the lowest orders of mankind, and gone out to practise amongst people belonging to the higher walks of life, must have learned the lesson that his customary doses frequently have to be reduced one-third, and even one-half, in order to meet the exigencies of his new class of patients.

Habits of life also modify the relations of the organism to drugs, in that they tend to the production of certain diseases. In malarial countries almost all diseases seem to require quinine. In hot climates depletion is very badly borne, and if we may believe recent statements even the relations of men and animals to anæsthetics are changed.

Among habits of life the constant use of certain drugs may well be considered as affecting treatment greatly. Especially must the practitioner be on his guard in respect to the effects of the habitual use of alcohol.

Doses of stimulants which would paralyze the ordinary individual make scarcely any impression upon the man who has long been used to taking a half pint of whiskey daily. Symptoms are so altered that in alcoholic subjects depressants often appear to be indicated when they are not, and even in the rare cases in which depletion really is demanded it is not safe suddenly to withdraw the daily dose of alcohol to which the subject has been long accustomed, and sometimes the best results are to be reached by continuing the alcohol and at the same time exhibiting depressing remedies. In the presence of an acute disorder he would be a bold physician who would advise the breaking off of the opium habit. As is well known, it is always dangerous to withdraw opium abruptly from a patient who has long been accustomed to its use. The nervous system, which might have been able to right itself if a week or ten days is given to the withdrawal of the narcotic, not rarely falls into collapse upon an immediate withdrawal of its customary stimulus. Many physicians appear to forget the possibilities of a prenatal alcoholic or opium habit. When, however, the female opium devotee brings forth a child, such offspring is prone within forty-eight hours to die of an apparently causeless collapse. The real cause of such collapse is probably the need of opium. The child in the first few hours finds itself not only struggling with the new conditions of life, but also totally deprived of its habitual nerve-stimulant, and it dies when its life might have been saved by doses of laudanum perhaps sufficiently large to kill an ordinary infant.

The power which the human system has of habituating itself to the influence of certain drugs is remarkable, especially when contrasted with the fact that the prolonged exhibition of certain other drugs seems to render the human frame more susceptible to their influences. The strangeness of the fact becomes still more apparent when it is recognized that even with a single individual drug like the iodide of potassium the system in some persons grows accustomed to its influence, whilst in other cases there is a gradual lessening of toleration, until finally the remedy cannot be given except in the most minute dose.

The laws which govern these peculiarities are at present unknown. It would seem, however, that vegetable drugs are more usually toler-

ated than mineral substances, and that in those cases in which the system becomes more sensitive to the action of a remedy there is usually either an accumulation of the drug in the body, or else the production of some local inflammation which is at the bottom of the intolerance.

It is often necessary for the physician to bear in mind the benumbing influence of "drug habit" in prescribing for cases which are essentially chronic. In such cases a drug which at first acts, it may be, most happily, often by and by loses its control. When under these circumstances the remedy is intermitted for a length of time, the sensitiveness of the organism to its influence usually returns. For these reasons the prescriber should substitute from time to time one remedy for another of the same class. Thus, in atonic dyspepsia after three or four weeks the extract of quassia may be replaced by the extract of gentian, and that in turn by the extract of chiretta, and so on; in chronic heart-failure, usually *before* digitalis has sensibly begun to lose its control, caffeine should be given in its place, and then strophanthus or adonidin may be essayed, or digitalis itself given again; in chronic constipation the salines may be followed by a combination of aloes, belladonna, and strychnine, and this in time should give way to rhubarb and colocynth or cascara sagrada. Thus, one after the other may the changes be carried out until the end of the chapter.

Emotions.—There is a school of philosophers, numbering among them some of the world's greatest scientists, who affirm that mental conditions are symbols of consciousness of the changes which take place automatically in the organism; that we are conscious automatons; that feelings can have no causal efficacy, produce no functional excitement of the nervous system, and no changes either in action or in structure; that they are, as Mr. Hodgson says, laid upon the surface, having no more influence upon the part below than the superficial colors upon the stone of the mosaic, consciousness itself being nothing more or less than a sort of aura or collateral function of the nervous system.

As a student of psychology I believe that these ideas rest upon pure dogmatism and assumption, and as a practical physician I know that the therapeutist who acts upon such theories will fail in his treatment of disease; and I suppose that to practical men the strongest proof of the truth or falsity of a theory is the practical results which follow its being brought to the test of every-day life. According to this theory, emotions are without influence, being themselves purely results of nervous excitement, mere reflexes of peripheral stimuli. There is no reason for believing that an emotion can exist apart from consciousness, and every physician must know that the waves of unusual emotional excitement are capable of profoundly influencing the nervous system for evil. I have seen the fright produced by a loud clap of thunder cause a chorea which lasted for many months. Abundance of cases

are on record in which an absolutely hopeless intellectual paralysis has been produced by the fright of a few minutes. Thus in a recorded case a girl, ready and apt, suffered rape and was left for life a hopeless idiot.

Without going further into this subject, because it is more or less foreign to the matter in hand, it suffices to reiterate that emotions have power for evil in their influences on nerve-matter, and that they also have power for good. When a resident physician in the Philadelphia Hospital years ago, in charge of a large ward of women, I habitually used a solution labelled "Morphine" which contained none of that alkaloid, but just enough quinine to make it conform in taste to the knowledge of the habitués of the institution, and in three cases out of five it aided in bringing comfort and rest, as well as did the genuine morphine solution. Some time ago I gave to a patient, with very minute and emphatic instructions as to the method of use, a prescription for pills of bread. Several months after she came back to me and said, "Doctor, why did you not give me that prescription sooner? It is the only thing that has reached my case, and I have had that prescription filled at the apothecary's for a number of my friends with extraordinary results."

The physician who fails to avail himself in disease of the "expectant attention" drops one of the most important articles out of his list of medicinal agencies. The history of quackery is full of lessons as to the truth of this. The innumerable certificates of the value of infinitesimal doses, and the successes of "Christian Science" and the "Faith Cure" in recent times, as well as the great relief afforded our grandfathers and grandmothers by Perkins's tractors, and the reputations of numerous charlatans,—all bear witness to the efficacy of faith as an agent of healing. Some years since there was in my employ a boy who had contracted malarial chills of a most obstinate variety, for which I myself had treated him through some months with great care, without preventing the occasional return of the paroxysms. Happening to have a medical friend well provided by nature with bald head, long beard, and solemn aspect, I had the boy taken by him into a partly darkened room and addressed in a very impressive manner, with the final statement that he would only have one chill more. The result coincided with the prophecy. After having been at Luys's Clinic in Paris, and watched the results obtained by hypnotism, I myself firmly believe that these results are the outcome of the effects of emotion upon the organism. The cures have been usually alleged by the believers in hypnotism as a therapeutic measure to be due to the suggestions made to the patients while in the hypnotic condition, and it has been asserted that these cures are proof that suggestions have an influence upon the nervous system without acting through the con-

sciousness of the patient. I believe that the patient often does not remember the suggestions when he recovers consciousness, but it must be borne in mind that the whole atmosphere of the place in which Professor Luys receives his patients is heavy with faith, and the scene of the daily clinic itself most weird and impressive—one, two, three learned doctors, with grave countenance and studied mien, going about among a number of individuals, commanding them at will, putting them asleep one after another, until the room is full of quiet automatons, who marshal themselves at the will of the physicians. At the clinic I noticed two things: first, that the patients were those whose nervous systems would naturally be expected to be influenced by "expectant attention;" second, that not rarely the assistants, in the hurry of the morning, made very slight suggestions and perhaps failed to suggest at all. After my return home, in my own wards at the University Hospital, by hypnotism without suggestions I obtained cures of palsies of standing, of tremors resembling those of paralysis agitans, and of other cases, some exactly simulating one or more of the most famous of Luys's cures. It appears to me that in the therapeutic history of hypnotism we have simply another example of the great influence of mind over matter. Tremors cease, convulsions fail to recur, and motion returns to paralyzed limbs, simply because the difficulty was always nothing more than a functional nervous disorder, which can be set aside by a nervous impression more powerful and profound than that which first produced the symptoms.

Temperament and Idiosyncrasy.—Temperaments may be defined to be peculiarities which characterize classes of individuals, whilst idiosyncrasies are peculiarities which belong to separate individuals. The word "temperament" is sometimes used by writers as synonymous with "diathesis," and yet the ideas expressed by the two terms are essentially different. Temperaments are natural conditions of the body which cannot be separated from any conception of the human race. Diathesis is defined by Billings to be "a state or condition of the body which predisposes to certain forms of disease." It is, in other words, a morbid tendency, a bodily peculiarity, which has been acquired by the individual himself or by the stock from which he has sprung, and which does not form a portion of an abstract conception of humanity.

The most usually accepted classification of temperament is into the nervous, the sanguine, the bilious, and the phlegmatic: but Dr. Thomas Laycock, who has written quite extensively on the subject, makes six divisions, which may be epitomized as follows:

1. Predominant innervation, or nervous temperament;
2. Predominant sanguinification, or sanguine temperament;
3. Predominant carbon excretion, or bilious temperament, associated with muscular activity and good innervation;

4. Tendency to fat-formation or deposit, with good muscular activity and low innervation and sanguinification; phlegmatic temperament.

5. Comparatively deficient innervation, sanguinification, muscular and vascular activity; lymphatic temperament;

6. Comparatively defective innervation, sanguinification, and vascular activity, with tendency to carbon deposit; melancholic temperament.

The American race is being formed by the fusion of individual elements of different origin, and it is rare to find an individual who closely approximates any typical definitions of the temperament. I do not think that in this country the question of temperament enters largely into the treatment of disease, unless it be in so far that there is a tendency to an excessive development of nervous sensitiveness, which is apt to be accompanied by excessive susceptibility to the action of remedies. In such individuals success is often obtained only by the use of doses which in phlegmatic subjects would produce no effect whatever.

The most important diatheses are the strumous and the gouty. When present they greatly modify the manifestations of acute and chronic diseases, and require careful and special treatment; but a discussion of this subject does not belong to a general introduction, and requires careful treatment in a separate chapter.

The physician who is desirous of success in his profession must always remember that he is treating not so much a disease as an individual, and that it is essential carefully to consult the peculiar tendencies, moral, mental, and physical, of the man or woman who is the patient. Some of these individual peculiarities occur so frequently that they may, to some extent, be foreseen. Thus, it will be found that in a large proportion of nervous, delicate, excitable women opiates produce violent nausea and after-depression, failing to act happily. For the greater part, however, idiosyncrasies are the peculiar properties of the individual, and cannot be known, even to the person most interested, except as the result of experience. They are often entirely unaccountable and beyond conception in their strangeness. Thus, a very active and renowned physician in Philadelphia is so susceptible to the odor of the hyacinth-plant that a single sprig of the flower in the room will produce in him nausea, followed by vomiting and collapse. A near relative of the writer was so susceptible to butter that the smallest portion of it, even cutting the bread with a knife that had been used to cut butter, would produce syncope. A physician, now dead, formerly a resident in the Pennsylvania Hospital, found that whenever he went on duty in the hospital he would become in a few days covered with boils, and so ill that he would be forced to go to bed. After this had been repeated a number of times it was discovered that it happened only when he was on duty in the surgical ward, but not until after he had resigned from the hos-

pital was it made out that the attacks were due to the effects on his skin of the vapors of the turpentine used at that time to clean the marks of sticking-plaster off of the patients. Again, I have known of cases in which a few grains of ipecacuanha diffused through the air would produce violent bronchial irritation. Every student of asthma is aware that there are persons in whom asthmatic attacks are precipitated by some presence, otherwise intangible, that hangs about the air of certain rooms. I have seen a few grains of quinine repeatedly produce complete blindness in the same individual, and in other cases cause severe violent urticaria, with so much disordered heart-action as to be very alarming. Another idiosyncrasy under my personal notice is that a few mouthfuls of lobster, boiled or broiled, will invariably produce an extraordinary and furious attack of herpes. These peculiarities are sometimes hereditary, as I know of a family in which eating an egg has in successive generations habitually caused in a few minutes violent headache, accompanied with fever, and after a short time an eruption upon the surface of the body.

Much space might be occupied with a description of the physical vagaries of humanity in their relations to drugs and to foods. The old saw, "One man's meat is another man's poison," expresses the whole matter. On the other hand, every physician is familiar with the fact that nothing is more common than for persons to imagine that they cannot take this or that remedy without the production of disagreeable and dangerous effects. Whilst, therefore, it is the duty of the doctor always, when called to a patient whose peculiarities are to him unknown, to inquire carefully for idiosyncrasies, care must be exercised in the proper weighing and appreciation of the statements made. I think that physicians more frequently err in refusing credence than in accepting too much.

Disease.—No circumstances affect the influence of medicine more than the morbid states of the individual that is being treated. For the purpose of discussion these morbid states can, at present, best be considered as follows: first, those for the remedying of which the remedy is given; second, those which are not being treated, but which at the same time may influence the action of the drug used.

It is evident that a direct antagonism often exists, if not between the medicine and the disease itself, at least between the drug and the cause of the disorder. A case of poisoning as the simplest example may be taken. We are so accustomed to considering poisonings as apart from disease that the illustration may not at first appear apt, but, after all, most acute disorders are nothing more or less than poisonings. There is no innate difference between an attack which is brought on by a mineral, vegetable, or animal poison that we call a drug because we use it in small dose for medical purposes, and an attack which is pro-

duced by a poison which we call a "natural cause" simply because we have not isolated the poison and employed it as the embodiment of a force capable, when properly used, of relieving human suffering. It is evident that if the system be under the influence of a drug A, which has produced a great depression of functional activity, a much larger amount of the drug B, which increases functional activity, must be used to produce a visible effect than would be required if the system were in normal condition. If a platform held up by a spiral spring be loaded with heavy weights, much greater force will be required to elevate it than would be otherwise required.

These remarks apply not only to the remedial, but to the physiological, action of drugs. In the man under the depressing influence of snake-poison, or of typhoid-fever poisons, or of the ptomaïnes and other products which have been produced in his own system by the diphtheritic coccus,—in such a man doses of alcohol that in health would cause drunkenness produce no acceleration of the pulse, no mental confusion, no disorder of locomotion, and, what is most strange and almost unaccountable, apparently are not eliminated. The power of the system under these circumstances of destroying the alcohol seems to be greatly increased beyond its normal limit, so that no odor appears on the breath, though the patient may be taking a pint of whiskey every twenty-four hours.

The resisting influence of one poison to that of another is felt both ways; the heart, that is stimulated by large doses of digitalis, responds less rapidly to the influence of aconite, precisely as one which is under the influence of aconite requires, in order for any appreciable effect to be produced, much more than the normal dose of digitalis. The mutual reaction of counteracting forces is easily understood, and would seem *a priori* to be a necessity inside of the human system as well as outside of it. It is not, however, so easily comprehended why conditions of body or of organs influence as much as they do the effects of remedies. It is, however, a thoroughly established clinical fact that the states of the body and of the tissues markedly affect the size of the doses which it is proper to use. In many cases of disease it is very difficult to decide how far the altered relations of medicine may be due to the direct counteracting influences of a poison, and how much to the conditions of the bodily forces. The cases of disease in which we have remedies that may be considered specific in character belong to this category. It is well established that malaria protects the general system from the action of quinine; twenty grains of the alkaloid will profoundly affect most normal individuals, whilst in malarial affections thirty, forty, and even fifty grains may be given without causing evidences of their physiological action. This may be due to the condition of the nervous system produced by malaria, but I think most physicians would be inclined

to suppose that it is the result of the quinine being resisted by the malarial poison itself or by some of its products in the human body.

On the other hand, the syphilitic person withstands doses of mercury or of iodides that ordinarily cannot be given. This, I think, would generally be considered to be due, not to the presence in the body of any primary or secondary poison, but to the altered nutritive state of the tissues. That bodily conditions do affect the drug relations of the human organism is certain. In pure and simple exhaustion, whether it has been produced by disease, by over-exertion, or by long-continued depressing influences, or whether it is secondary to the over-use of a stimulant, much larger amounts of stimulants are required to make an impression than in health. In delirium tremens, in insomnia from excessive brain excitement, doses of narcotics which in health would almost paralyze fail to produce sleep. The heart that is weakened by structural changes responds but slowly to the largest doses of digitalis; the kidney that is fatty or atrophied is sluggish in all its reactions; the stomach whose mucous membrane is inflamed and whose blood-vessels are dilated by habitual alcoholic excess scarcely perceives the irritating influences of the largest doses of capsicum.

From considerations such as these certain practical deductions naturally result. In most cases of general disorder the drug-forces may work in a manner that is antagonistic to the influence of the poison that is already present, or to the condition that is already present in the system. Usually, the indication is for the employment of those drug-forces which are antagonistic to the poison or condition. Remedies of this character are usually well borne, as it is technically expressed—*i. e.* they may be given and may do good in doses which are much larger than those of the textbooks. At the same time, it must never be forgotten that a fatal effect may be produced by over-dosing in these cases without the most prominent of the symptoms of the disorder being overcome. Especially is this true because most drugs have more than one action. As an example, take delirium tremens: if the practitioner insists at all hazards upon enforcing sleep by opium, he may do the patient fatal injury; in a case of tetanus convulsions can always be suspended summarily by the use of anæsthetics, chloral, and similar drugs, but the suspension of the convulsion may be accomplished at the cost of the patient's life. Sometimes, moreover, the drug which has failed to produce any symptoms of its action for a long time seems suddenly to overcome the antagonistic force and at once to act upon the system.

A curious and almost inexplicable illustration of the fact that a remedy may be acting when apparently it is exerting no influence sometimes occurs in the use of mustard plasters in conditions of excessive irritation. Thus, I have repeatedly known a person suffering from

some violent internal irritation, with excessive pain, to allow a strong mustard plaster to stay on the skin perhaps for several hours without there being produced at the time any smarting, redness, or appreciable effect on the surface, although on the following day there was developed violent inflammation, with vesication or even sloughing of the skin, confined exactly to the site of the mustard plaster, proving that a very active effect had been produced by the plaster, although such effect was at first completely masked by the internal irritation. The mustard plaster counter-irritates against an internal irritation, but the internal irritation also counter-irritates against the mustard plaster. What takes place upon the surface of the body, openly and visibly to our senses, may also occur internally in a hidden manner. The utmost caution should therefore be practised in using drugs against internal poisons or diseases in such doses as would, in a healthy individual, actually endanger life; only under peculiar circumstances are these doses justifiable.

Diseases which affect the influence of drugs not used against them are commonly local affections, which are of importance solely as offering some objection to employment of the otherwise indicated drugs. My experience has been that these side issues, so to speak, are frequently lost sight of by practising physicians, with great resulting injury to the patients, so that I think that it is not a waste of space to make detailed mention of some of the more frequent of them. Irritability and inflammation of the mucous membranes of the stomach and bowels contraindicate tonics, since simple bitters, quinine, nux vomica, and most preparations of iron are more or less irritating. Very many cases of general debility depend upon chronic irritation of the stomach or intestines. A little habitual diarrhœa, which consists simply of one loose passage a day, is apt to be overlooked, and the resulting debility is improperly treated with quinine and iron and similar remedies.

Of all ordinary remedies quinine is the one most frequently contraindicated by local disease at a time when it is indicated by the general condition. It is powerfully irritant to the gastro-intestinal tract: it congests or increases an already existing congestion of the middle ear, and is undoubtedly, when used too freely, capable itself of causing middle-ear deafness. It should never be given when there is a tendency to such disorder unless actually necessary for the saving of life.

The irritating influence of drugs is felt not only at their point of entrance, but also at their point of exit; hence, most irritants are contraindicated by the existence of irritation or tendency to irritation in the urinary organs. Quinine, when given freely, very greatly irritates the mucous membrane of the bladder, and for this reason in old persons who are prone to bladder irritability it must always be used with caution. Not long since I was paying a visit to a well-known

surgeon, who was recovering from an attack of prostatic abscess under the care of an equally renowned surgeon. Convalescence was absolutely in abeyance, owing to a violent pain in the neck of the bladder which came on every afternoon. On inquiry I found that quinine was being given freely as a tonic, and when I told my surgical friends that I believed it was the cause of the pain, there was a good deal of astonishment; nevertheless, when the quinine was stopped the pain rapidly subsided.

The unreliability of empirical therapeutics, as well as the credulity of physicians in regard to absurd assertions, is seen in the enormous use which has been made of potassium chlorate in diphtheria. The administration of the chlorate seems to have been based on the theory that it would yield nascent oxygen in the system and so purifies the blood. Potassium chlorate is decomposed, however, only at a white heat. When ingested it is eliminated, unchanged, as the chlorate, and there is not the slightest reason for supposing that it is decomposed in the human system or that it has any influence in diphtheria, save only as it exerts a slight local influence upon diseased mucous membranes. On the other hand, one of the chief dangers of diphtheria is nephritis, and potassium chlorate is a violent irritant to the kidneys; yet it has been given almost universally in enormous doses in diphtheria. I have no doubt that a notable percentage of the deaths set down to diphtheria have been due in fact to the potassium salt.

On the Combining of Drugs.

In prescribing medicines the physician ought always to bear in mind that the forces which he employs are capable of acting for evil as well as for good, and that in consequence drugs are not to be administered without good reason for their use. Such a principle as this is directly opposed to the habit of polypharmacy—*i. e.* to the custom of combining a large number of drugs into one avalanche of unknown and unknowable power. When a dozen active and perhaps more or less antagonistic agencies are thrown together into one confused mass, who can tell what will be the resultant angle of forces? If simplicity be not an unerring sign of the master in medicine, multiplicity of combination is without doubt the mark of the bungler and of the ignoramus. It is usually better to prescribe powerful remedies singly, but when circumstances seem to demand a combination of remedies such combination should only be made in accordance with definite rules or principles.

A very important consideration in regard to the combining of drugs, one which is not rarely lost sight of, is that even when drugs are to be exhibited together it is frequently better to keep them separate and uncombined, because the exigencies of the case may well require varia-

tions of the dose of the one without corresponding increase or decrease of the dose of the other. This is especially true when one medicine is comparatively inert and the other very active, or when it is desired to push one or more of the remedies to the full physiological limit. Even such learned and practical men as the framers of the U. S. Pharmacopœia have lost sight of this principle in various cases. According to my thinking, it is hard to conceive of a greater pharmaceutical abomination than the official iron and strychnine citrate, which is made upon the principle of hitching together an ox and a race-horse. The iron preparations are of slow action, and in most cases it makes very little difference whether more or less than the average dose of them is given. Strychnine is a powerful and rapid remedy, whose dose should always be carefully graduated to the individual case of disease. The officinal preparation has no advantages whatever, and has the great disadvantage of leading the doctor to prescribe in a routine way without attempting to adapt doses to the needs of the individual patient. Even such preparations as the iodide of iron are somewhat open to this objection. Very few physicians have any idea how much iodine the patient is getting when he is taking twenty drops of the syrup of the iodide of iron; and if the two remedies are to be given to the child, in my opinion it is generally better to give iron as iron and iodine as iodine.

The most important and practical of the rules governing the combining of remedies are as follows: First, *medicines are combined together to meet several coexisting indications.* The purpose expressed in this law is the one which most frequently leads to the use of the multiplicity of drugs, so that the practitioner should always remember the importance of not being led away by minor pointings of nature. An illustration of the application of the present law is in a prescription for a cough mixture in the first stages of a bronchial inflammation. In an ordinary case the indications would be to bring about secretion; hence the following prescription, in which two substances, the citrate of potassium and the syrup of ipecacuanha, are used to fulfil the indications, whilst the syrup and the lemon-juice are added to make the mixture less nauseous to the stomach:

℞. Potassii citratis, ʒj;
Succi limonis, fʒiss;
Syr. ipecacuanhæ, fʒss;
Syrupi, q. s. ad fʒiij.

S. Dessertspoonful every two hours.

Supposing, however, there should be in any case an excessive nervous cough, morphine or some other narcotic might advantageously be added to the foregoing prescription, or if there were considerable arterial

excitement the indication would be for the addition of tartar emetic or a similar remedy.

Second, *substances are combined for purposes of joint action or to modify the influence one of the other.* The application of this law is best illustrated by a purgative combination. Supposing a substance, A, acts upon the mucous membrane of the large intestine, while substance B influences especially the smaller intestine, and substance C affects the muscular coat. It is evident that when a thorough purgative action is desired the combination of all these three will act better than either remedy alone. It is for this reason that such polypharmaceutical preparations as the compound cathartic pill especially prevail among purgative remedies. Then, again, it has been found that certain narcotic substances lessen the irritation produced by the cathartic; hence narcotics are often put into purgative combinations to modify the action of the purgatives. Laudanum is habitually exhibited with castor oil, and the extract of belladonna added to the purgative pill.

Third, a very important law of combination is that which I venture to call *the law of crossed action.* Suppose, for instance, that a certain remedy, A, influences the system in such a way that its action can be represented by a horizontal line which runs through the point X, whilst the action of B is properly represented by a vertical line which also passes through the point X. It is evident that the point X will receive an impression proportionately much stronger than that of any other point of the body. A practical illustration of the value of this law is found in the great utility as a hypnotic of a mixture of chloral and morphine. Chloral acts upon the cerebral cortex as a somnifacient, and at the same time affects the heart and the spinal cord. Morphine acts upon the cerebral cortex as a somnifacient, but has little or no influence upon the spinal cord or the heart, although it is prone to disarrange digestion. A mixture of chloral and morphine, therefore, whilst powerfully acting upon the cerebral cortex as a hypnotic, influences the heart and spinal cord much less forcibly than would a corresponding dose of chloral, and disarranges digestion much less severely than would the corresponding dose of opium.

In the process of combining drugs the physician practises the art of prescription-writing, but as Professor Remington is to discuss this art in detail, my remarks upon it shall be restricted to a few considerations which might readily be everlooked by one who looks at the subject solely from a pharmaceutical point of view.

Almost every prescription consists of two parts—the vehicle and the remedy or remedies. In the case of mixtures or solutions it is usual for the physician to state what vehicle shall be employed. When a solid preparation is to be made, however, the choice of the excipient should be left to the apothecary, who will be much more apt than the

physician to know the exact physical and chemical qualities required, as well as the necessary quantities.

Almost as great a reproach to the doctor as polypharmaceutical prescriptions is the habit of changing medicine unnecessarily and of prescribing it in too large quantities. Time is usually required for any effect to be produced by remedies, and a great array of unused bottles is, to many sick persons and their friends, a great aggravation. Care should be taken to adapt the number of doses in a prescription to the probable length of time during which it shall be used; not to prescribe fifty pills or a pint of mixture when ten pills or a few ounces are all that will be required.

Most medicines are nauseous. Among certain semi-barbarous tribes and peoples, including Irishmen and Irishwomen of the peasant class, the disagreeableness of a drug is intimately associated with the expectation of relief; but in this present age of over-comfort and luxury the physician who hopes to be successful amongst the better classes of society will carefully study the art of rendering medicine as little unpleasant as possible. In doing this certain general rules of practice may be followed out. A remedy should not be given in a liquid form when it can as well be administered in solid. When the solid form is chosen it should be one that is readily soluble in the stomach, and at the same time insoluble in the mouth, as far as may be. The pill is better than the powder, but the gelatin capsule is better than the pill, because it is tasteless and at the same time rapidly disappears in the stomach. Sugar-coated pills were in their time an admirable product of the pharmaceutical art; at present they are inferior. Gelatin-coated pills are more readily soluble and as readily taken. A favorite preparation with many practitioners is the compressed pill, and when properly made of a substance fitted for this method of exhibition it is very commendable, on account of the smallness of its size in proportion to the dose which it contains. On the other hand, as it is often put upon the market composed of entirely insoluble substances, it may be a delusion and a snare. The basis of it should always be soluble. A compressed pill of quinine should be made of the bisulphate, and not of the sulphate. A compressed pill of a substance as insoluble as sulphonal should never be made at all. The popularity of the compressed pill of sulphonal I think is one reason why this drug has so frequently failed in practical medicine. Probably any one who will watch the passages from the bowels of a patient taking these pills will find the pills, as I have done, discharged from the anus almost as fresh and bright as when taken into the mouth. If, instead of being made into a solid mass, the powder of suphonal, quinine, or other insoluble remedy be pressed not too tightly into a capsule, the best method of administration is obtained. Volatile oils and similar liquids, whose dose is small, are usually, when disa-

greeable in taste, best given in the capsules. The ordinary hard capsule, one-half of which slips into the other, is always leaky, and should never be used for liquids. These should always be hermetically enclosed in the so-called soft capsules. Most persons can readily swallow a soft capsule containing one or two drachms. The use of the pill or capsule with very irritating substances requires some caution, lest the concentrated irritant should come in contact with the mucous membrane of the stomach. Not rarely this difficulty can be well met by administering the drug only when the stomach is full or by taking liquid with the dose, or by mixing the drug with some inert substance before encapsulating.

PRESCRIPTION-WRITING AND THE COMBINATION OF DRUGS.

By JOSEPH P. REMINGTON, Ph. M.

Prescriptions.

The prescription[1] is the written direction of a physician indicating the remedy for a disease. All prescriptions may be classified under the two divisions—"official," or permanent, and "magistral," or extemporaneous.

"Official" prescriptions include all formulæ that are issued under official authority, as, for example, those of the various pharmacopœias, which are official in the various countries where the several pharmacopœias are issued. In the United States, however, those only are considered official that are contained in the "United States Pharmacopœia," which is issued by the authority of the Pharmacopœial Convention, a body convened especially for the purpose; or semi-official if by the "National Formulary," which is published under the authority of the American Pharmaceutical Association. Prescriptions for official formulæ can nearly always be dispensed by the pharmacist without delay, as official prescriptions are made in advance and are kept on his shelves ready for use.

"Magistral" prescriptions include such as are made up extemporaneously by the pharmacist according to special directions, and embrace those ordinarily prescribed by the physician: these are "unofficial," and might properly be called officinal, but this term has been used so long in the United States as meaning official that its use in this connection would no doubt lead to confusion.

A further great division of these two classes separates them into such as are used internally and such as are used for external application, and these are again subdivided into "Liquids" and "Solids," which are still further separated into groups or classes based upon similarity of composition or mode of preparation.

In writing prescriptions there are so many points to be considered that it requires rare knowledge and judgment to avoid falling into some mistake or inaccuracy, and prescriptions that can be considered as models in all respects are not frequently met with. They should always be written in a clear, legible hand on clean white paper, and with pen

[1] *Præscriptio—præ*, "before," and *scribo*, "I write."

and ink; if written with lead-pencil (which many physicians are in the habit of using), the characters are very apt to become blurred and indistinct before reaching the pharmacist.

Latin names should be used to designate the ingredients of the prescription, as being more definite and precise than English names. Latin being a dead language, its rules are fixed and established, and not liable to changes of fashion or fancy, as are living languages. It has been chosen as the language of science in all countries, and is the great storehouse from which the scientific world has ever been accustomed to draw its technical phraseology. The chief merit of Latin is its precision, and in no science is precision more important or necessary than in medicine. The Latin name applied to a drug is specific and has but one meaning, while in English the same name is often applied to many drugs; as, for example, "Indian hemp" is applied to Cannabis Indica, to Asclepias incarnata, and also to Apocynum cannabinum, drugs having entirely different properties. "Hellebore" is applied to Helleborus Americana, to Helleborus niger, to Veratrum album, to Veratrum viride, and to Dracontium fœtidum. "Snake-root" is applied to Aristolochia serpentaria, to Asarum Canadense, to Cimicifuga racemosa, to Eryngium aquaticum, to Eupatorium aromaticum, to Liatris spicata, to Macrotis, to Polygala senega.

On the other hand, many names are frequently applied to one drug; thus, "Gaultheria procumbens" is called checker-berry, box-berry, deer-berry, grouse-berry, spice-berry, tea-berry, partridge-berry, berried tea, gaultheria, trailing gaultheria, ground ivy, spicy wintergreen, and mountain tea.

It is frequently desirable that the patient should not be advised of the name of the medicine prescribed, and this object may generally be attained by the use of Latin.

When an unusually large dose of medicine is prescribed, it should be marked in some special way to show that such a dose is not a mistake, but is intended; this may be done by a note at the bottom of the prescription: "Correct dose" or "Intentional;" or by writing out the specific quantities in letters as well as in symbols or figures; thus, "ʒj (one drachm), gr. xxv (twenty-five grains);" an unusual dose is sometimes emphasized by underscoring or by an exclamation-mark, thus (!). When such precaution is not used a careful pharmacist may refuse to put up the prescription before consulting the physician, and thus valuable time may be lost.

Abbreviations of names are allowable only where there can be no doubt of their meaning, and such as may possibly admit of more than one meaning should be studiously avoided. The name of each ingredient and the quantity or amount of it required should always be placed on the same line.

Prescriptions should never be written partly in Latin and partly in English; such writing is evidence of either carelessness or ignorance. It is customary with some physicians to commence their prescriptions by writing down the names of the medicines which they intend to give, and afterward putting in the quantity desired of each article; objections to this plan are the liability or danger of transposing the quantities, or from oversight omitting to put down the quantity of one or more of the ingredients.

The physician should always sign his name to a prescription: the use of printed forms or prescription-blanks is very common, and very useful as giving the name, residence, and office-hours of the prescriber. If such forms are not used, it becomes still more important and desirable that the physician should sign his name to the prescription, so that in case of doubt or difficulty, either on account of the illegibility or any actual or supposed mistake, the pharmacist could communicate with the physician without the necessity of going to the patient and without the knowledge of the latter.

The name of the person for whom the prescription is intended should be written upon it, especially where there are two or more patients in the same house; as also the date when written. These precautions will frequently prevent mistakes which might otherwise occur; the date makes it convenient for reference, and may become of great importance from a medico-legal point of view.

Although there is no inflexible rule by which the order of the ingredients in a prescription may be determined, yet by following certain directions their best arrangement may be secured. A model prescription consists of some or all of the following parts:

1st. The superscription or heading;

2d. The inscription or enumeration of the ingredients, with their quantities;

3d. The subscription, or directions to the pharmacist;

4th. The signa, or direction for the patient as to the use of the medicine.

In addition to these parts should be added the name of the patient, the date when written, and the name of the physician, together with his address.

The superscription in Latin prescriptions consists of the letter ℞, the first letter of the word *Recipe* (take), being the imperative of the verb *recipio*. The most important part of the prescription is the inscription, the part requiring the knowledge and judgment of the physician in selecting the various remedies to be employed and apportioning their quantities. The principal active ingredient of a prescription is called the "basis;" this may be prescribed alone or in combination with other remedies. The next important ingredient in a mixture is the "vehicle," or, as sometimes called, the "diluent," which

furnishes the means of dividing and giving the proper dose of the medicine. If another medicine be added to assist the basis, it is called the "adjuvant," while articles intended to modify or qualify the action of the active ingredients are called "correctives."

The subscription is the direction to the pharmacist for compounding the prescription. Formerly it was the custom of the physician to give full directions for mixing the ingredients of a prescription and for compounding generally; these points are now usually left to the skill and judgment of the pharmacist, who is presumed to know how certain ingredients should be mixed, and short directions are generally given, such as misce (mix), solve (dissolve), fiat solutio, mistura, or pilula, as the case may be, leaving the mode of mixture and choice of excipient entirely to the pharmacist.

The signa, or direction intended for the patient, usually abbreviated "Sig.," or sometimes simply "S.," should always be written in English, distinctly and without abbreviation; written in Latin, it seems pedantic; besides which, there is liability to error in having the pharmacist translate it for the patient, who will certainly require it to be in English.

The following, illustrative of a modern model prescription, is given with a view of showing all of the parts:

Sept. 10, 1891.

For Mrs. E. M. T——.

Recipe (*Take*) — *Superscription.*

(*Basis.*) Extracti rhamni purshiani fluidi, fluidunciam;
Of fluid extract of cascara sagrada, 1 fluidounce;

(*Adjuvant.*) Extracti sennæ fluidi, semifluidunciam;
Of fluid extract of senna, ½ fluidounce;

Extracti glycyrrhizæ fluidi, fluidrachmas duas;
Of fluid extract of liquorice, 2 fluidrachms;

(*Corrective.*) Elixir aromatici, fluiduncias tres;
Of aromatic elixir, 3 fluidounces;

(*Vehicle.*) Syrupi, quantum sufficit ut fiant fluidunciæ sex;
Of syrup a sufficient quantity to make 6 fluidounces; — *Inscription.*

Misce, et filtra si opus sit.
Mix, and filter if necessary. — *Subscription.*

Signa (*mark or label*), *a dessert-spoonful at night.* — *Signa.*

GEORGE B. WOOD.

ABBREVIATED FORM.

Sept. 10, 1891.

For Mrs. E. M. T——.

℞. *Ext. rham. pursh. fld.*, *f℥j;*
Ext. sennæ fld., *f℥ss;*
Ext. glycyrrh. fld., *f℥ij;*
Elix. aromat., *f℥iij;*
Syrup. q. s. ft. *f℥vj.*
M. et filt. si op. sit.

Sig. A dessert-spoonful at night. *G. B. W.*

Weights and Measures.—The ordinary weights and measures used in pharmacy and medicine are relics that have been bequeathed from a

past age, in which lack of system and uniformity are painfully apparent; they are as follows:

Apothecaries' Weight (also called Troy Weight).

Libra, Pound.		*Uncia*, Troy Ounce.		*Drachma*, Drachm.		*Scrupulus*, Scruple.		*Granum*, Grain.
℔ 1	=	12	=	96	=	288	=	5760
		℥ 1	=	8	=	24	=	480
				ʒ 1	=	3	=	60
						℈ 1	=	gr. 20

The British Pharmacopœia has adopted avoirdupois weight, which is also in general use in the United States for commercial purposes.

Avoirdupois Weight.

Pound.		Ounces.		Grains.
℔ 1	=	16	=	7000
		oz. 1	=	437.5

It will be observed that the troy ounce contains 42½ grains *more* than the avoirdupois ounce, whilst the troy pound contains 1240 grains *less* than the avoirdupois pound. Fortunately, one unit common to troy, apothecaries', and avoirdupois weight has been saved—namely, *the grain*. The abbreviations of the denominations of apothecaries' weight are represented by the signs ℥, ounce; ʒ, drachm; ℈, scruple; and gr., grain: these have long been in use, but are very likely to be mistaken for one another in rapid or careless writing. The abbreviations or signs for avoirdupois weight differ from those of troy weight, and care should be used not to confound them; they are ℔., pound; oz., ounce; gr., grain.

MEASURES.

Apothecaries' or Wine Measure, U. S.

Congius, Gallon.		*Octarius*, Pint.		*Fluiduncia*, Fluidounce.		*Fluidrachma*, Fluidrachm.		*Minimum*, Minim.
Cong. 1	=	8	=	128	=	1024	=	61440
		O 1	=	16	=	128	=	7680
				f℥ 1	=	8	=	480
						f℥ 1	=	♏ 60

Imperial Measure, Br.

(Adopted by the British Pharmacopœia.)

Congius, Gallon.		*Octarius*, Pint.		*Fluiduncia*, Fluidounce.		*Fluidrachma*, Fluidrachm.		*Minimum*, Minim.
C. 1	=	8	=	160	=	1280	=	76800
		O 1	=	20	=	160	=	9600
				fl. oz. 1	=	8	=	480
						fl. dr. 1	=	min. 60

When the subject of the weights and measures in ordinary use is studied, the want of simplicity and close relation is clearly apparent. The pint of distilled water at 15.6° C. (60° F.) weighs 7291.2 grains, the fluidounce 455.7 grains, and we have thus three ounces in use of

different values: troy ounce, 480 grains; avoirdupois ounce, 437.5 grains; and fluidounce, 455.7 grains.

The Imperial measure differs from our wine measure principally in having twenty fluidounces in the pint instead of sixteen: a convenient relation exists, however, between measure and weight in the *Imperial gallon, which contains ten avoirdupois pounds of water at* 15.6° C. (60° F.).

The Imperial fluidounce contains the same number of grains as the avoirdupois ounce (437.5), which is 18.2 grains less than that of the U. S. fluidounce of water at the same temperature (455.7). Although this difference may be considered trifling in one fluidounce, it is not so when multiplied by four or eight; and this is one serious objection to the use of the English graduated measures in the United States, because they indicate Imperial fluidounces instead of U. S. fluidounces.

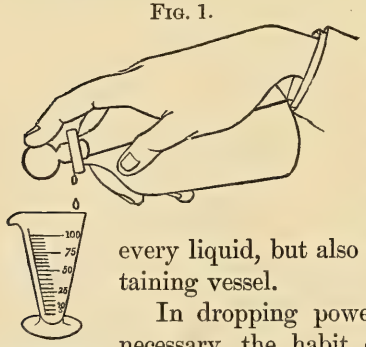
Much discussion has arisen respecting the comparative accuracy of preparing prescriptions by weighing or measuring. In the hands of a careful pharmacist either method will be found satisfactory, while with a careless one neither will be accurate. When, however, the difference in dosage, resulting from difference in size of spoons with which medicines are usually administered, is considered, the difference between the two methods will usually be insignificant. As liquid medicines are always given by measure, it would seem to be most rational to *prescribe liquids by measure*, and thus avoid the necessity for calculating the difference in dose due to the difference between weight and volume. In English-speaking countries the custom is firmly established of *weighing solids* and *measuring liquids*.

For convenience the following domestic measures are commonly used:

The tea-cup	(poculum)	equal to	fʒiv
wine-glass	(cyathus vinarius)	"	fʒij
table-spoon	(cochlear magnum)	"	fʒiv
dessert-spoon	(cochlear medium)	"	fʒij
tea-spoon	(cochlear parvum)	"	fʒj.

All of the above measures vary very considerably in value, and therefore where accurate dosage is important the use of graduated glass measures or medicine-glasses, which can now be readily obtained, should be insisted on. The drop is usually considered to be equivalent to the minim; it is nearly so in the case of water, but varies not only with every liquid, but also with the size and shape of the containing vessel.

Fig. 1.



Dropping from Shop-bottle.

In dropping powerful liquids or when great care is necessary, the habit of holding the bottle as shown in Fig. 1 should be cultivated.

The Metric System in Prescriptions.—In view of the adoption of the metric system by the United States Pharmacopœia (1890) it is necessary that every pharmacist, and most desirable that every physician, should understand how to read and write prescriptions in this method. In order to avoid mistakes, a correct knowledge of the terms employed, together with a just appreciation of their values, is essential. The terms usually employed should be so thoroughly understood that when met with definite ideas of weight, capacity, or length, as the case may be, are immediately conveyed to the mind, without requiring a comparison with, or conversion into, ordinary or accustomed measures.

In Germany and some other continental countries prescriptions are prepared almost exclusively by weight, liquids as well as solids being thus dispensed, and quantities are all expressed in grammes. In this country, however, it is the custom to weigh solids and to measure liquids, with the exception of a few oily or viscid liquids, in which special cases weighing becomes more convenient than measuring.

The quantities employed in prescriptions are usually designated by multiples or subdivisions of the gramme for solids and of the cubic centimetre for liquids. Gm. is the abbreviation ordinarily used for the gramme, and c.c. that for the cubic centimetre, and they are always written after the quantities, thus differing from the ordinary method of writing prescriptions; moreover, the quantities are expressed in Arabic numerals, and not in Roman figures, again differing from the usual style.

The gramme is equivalent to about 15.5 grains (more exactly 15.432 grains), and the cubic centimetre is the measure of a gramme of distilled water; in order more thoroughly to show the relation existing between these, a cubic centimetre is sometimes called a fluigramme; this is equivalent to about 16 minims (more exactly 16.23 minims), and consequently 1 grain is equivalent to about 0.06 c.c. (6 hundredths of a cubic centimetre). The gramme is divided into 10 decigrammes, or 100 centigrammes, or 1000 milligrammes.

The term "decigramme" is rarely used, quantities being usually expressed in grammes and centigrammes; just as in our decimal currency we usually reckon by dollars and cents, seldom using dimes. Where fractions of a centigramme occur they are usually designated as so many milligrammes.

All the measures in this system are derived from the metre, hence it is called the Metric System; it is also called the Decimal System, because all the measures bear decimal relations to each other. The unit of length is the "metre," which is the forty-millionth part of the circumference of the earth around the poles: from this are derived all the other measures, including those of length, capacity, weight, and

area. The unit of capacity is the "litre," which is the measure of a portion of water that would just fill a hollow cube each side of which measures one-tenth of a metre. The unit of weight is the "gramme," which is the weight of a portion of water that would just fill a hollow cube each side of which measures one-hundredth of a metre; hence it is sometimes called a cubic centimetre (c.c.).

From these units the other measures are derived, and are designated by prefixes: those which indicate increase are derived from the Greek. while those which indicate decrease are derived from the Latin. The Greek prefixes are deka, 10; hecto, 100; kilo, 1000; and myria, 10,000. The Latin prefixes are deci, $\frac{1}{10}$; centi, $\frac{1}{100}$; and milli, $\frac{1}{1000}$; and these prefixes to the names of the units give the following tables:

Metres.		Litres.		Grammes.	
1 millimetre, mm. =	.001	1 millilitre, ml. =	.001	1 milligramme, mg. =	.001
1 centimetre, cm. =	.01	1 centilitre, cl. =	.01	1 centigramme, cg. =	.01
1 decimetre, dm. =	.1	1 decilitre, dl. =	.1	1 decigramme, dg. =	.1
1 metre, m. =	**1.**	**1 litre, l. =**	**1.**	**1 gramme, gm. =**	**1.**
1 dekametre, dm. =	10.	1 dekalitre, dl. =	10.	1 dekagramme, dg. =	10.
1 hectometre, hm. =	100	1 hectolitre, hl. =	100.	1 hectogramme, hg. =	100.
1 kilometre, km. =	1,000.	1 kilolitre, kl. =	1,000.	1 kilogramme, kg. =	1,000.
1 myriametre, mm. =	10,000.	1 myrialitre, ml. =	10,000.	1 myriagramme, mg. =	10,000.

It will be observed that the significant unit in all of the above tables is 1, and that the differences in value are distinguished by the position of the decimal point; hence it is all important that this point should be properly placed. In writing prescriptions the use of a line to distinguish between grammes or cubic centimetres and their fractions, similar to the line used for dividing dollars and cents in books of account, is safer and less liable to error than the use of the decimal point; it is also much more convenient than writing the denominations after each quantity, as is sometimes done. These methods are illustrated by the following prescriptions:

	Gm. & c.c.
Tinct. ferri chlor.,	2|5
Acid. acet. dilut.,	3|75
Liq. ammon, acet.,	25
Elixir aurantii,	12|5
Syrupi,	20
Aquæ, q. s. ut ft.	60

M. Ft. sec. art.

	Gm.
Tinct. ferri chlor.,	2.5
Acid. acet. dilut.,	3.75
Liq. ammon. acet.,	25.
Elixir aurantii,	12.5
Syrupi,	20
Aquæ, q. s. ut ft.	60

M. Ft. sec. art.

Tinct. ferri chlor.,	2.5 gm.
Acid. acet. dilut.,	3.75 gm.
Liq. ammon. acet.,	25 gm.
Elixir aurantii,	12.5 gm.
Syrupi,	20 gm.
Aquæ, q. s. ut ft.	60 gm.

M. Ft. sec. art.

	Gm. & c.c.
Ext. coloc. comp.,	2
Abst. jalapæ,	1.5
Hyd. chlor. mitis,	1.75
Pulv. gambogiæ,	.4

Misce et div. in pil. No. xxv.

	Gm.
Ext. coloc. comp.,	2.
Abst. jalapæ,	1.5
Hyd. chlor. mitis,	1.75
Pulv. gambogiæ,	.4

Misce et div. in pil. No. xxv.

Ext. coloc. comp.,	2 gm.
Abst. jalapæ,	1.5 gm.
Hyd. chlor. mitis,	1.75 gm.
Pulv. gambogiæ,	.4 gm.

Misce et div. in pil. No. xxv.

	Gm. & c.c.
Pulv. cretæ,	7.5
Pulv. acaciæ,	5
Pulv. sacchari,	12.5
Aquæ cinnam.,	60
Aquæ, q. s. ut ft.	cxx.

	Gm.
Pulv. cretæ,	7.5
Pulv. acaciæ,	5
Pulv. sacchari,	12.5
Aquæ cinnam.,	60
Aquæ, q. s. ut ft.	cxx.

Pulv. cretæ,	7.5 gm.
Pulv. acaciæ,	5 gm.
Pulv. sacchari,	12.5 gm.
Aquæ cinnam.,	60 gm.
Aquæ, q. s. ut ft.	cxx. gm.

It will be observed that in the above prescriptions both the volumetric and gravimetric methods are used. In the gravimetric method liquids as well as solids are weighed, while in the volumetric method solids are weighed and liquids are measured; cubic centimetres (c.c.) being used in place of grammes.

Instead of learning rules for converting ordinary weights and measures into those of the metric system, it will probably be found more convenient and less difficult to memorize a few equivalent values, and from these to calculate other values.

The following equivalents will be found useful:

Lengths.

1 inch, about 25 mm. (25.3997 mm.).
1 foot, " 30 cm. (30.48006 cm.).
1 yard, " 91 cm. (91.44010 cm.).

Liquid Measures.

$\mathfrak{m}$j = about 0.06 c.c. (.0616 c.c.).
f$\mathfrak{z}$j = " 3.75 c.c. (3.6967 c.c.).
f$\mathfrak{Z}$j = " 30 c.c. (29.5739 c.c.).
Oj = " 500 c.c. (0.47318 L.).
Oij = " 1000 c.c. (0.94636 L.).

Weights.

gr. j = about 0.06 gm. (64.7989 mg.).
gr. xv = " 1 gm. (97.189 cg.).
ʒj = " 4 gm. (3.8879 gm.).
℥j = " 30 gm. (31.10348 gm.).

The equivalents of French measures are as follows:

Lengths.

1 millimetre, mm. = about $\frac{1}{24}$ inch.
1 centimetre, cm. = " $1\frac{5}{12}$ inches.
1 decimetre, dm. = " 4 "
1 metre, m. = " $39\frac{3}{8}$ "

Liquid Measures.

1 millilitre, or cubic centimetre, c.c. = about ♏16.
1 centilitre, or 10 cubic centimetres = " f℥$2\frac{3}{4}$.
1 decilitre, or 100 cubic centimetres = " f℥$3\frac{3}{8}$.
1 litre, or 1000 cubic centimetres = " f℥34.

Weights.

1 milligramme, mg. = about $\frac{1}{64}$ grain.
1 centigramme, cg. = " $\frac{1}{6}$ "
1 decigramme, dg. = " $1\frac{1}{2}$ "
1 gramme, gm. = " $15\frac{1}{2}$ "

Inasmuch as many of the terms and titles used in medicine and pharmacy to-day were unknown to the ancients, new names based on Latin types have become a necessity: the following condensed glossary, however, will prove serviceable in presenting nearly all of the terms and phrases in common use that are likely to occur in prescriptions:

CONDENSED GLOSSARY.

Abdomen,	The belly,	Abd.
Absente febre,	Fever being absent,	Abs. feb.
Accurate,	Accurately,	Acc.
Ad,	To, or up to,	Ad.
Ad defectionem animi,	To fainting,	Ad def. an.
Ad duas vices,	At twice taking,	Ad 2 vic.
Ad gratam aciditatem,	To an agreeable sourness,	Ad. grat. acid.
Ad libitum,	At pleasure,	Ad lib.
Ad secundum vicem,	To the second time,	Ad sec. vic.
Ad tertiam vicem,	For the third time,	Ad 3 tiam vic.
Addantur,	Let (them) be added,	Add.
Adde,	Add,	Add.
Addendo,	By adding,	Add.
Addendus,	To be added,	Add.
Adhibendus,	To be administered,	Adhib.
Adjacens,	Adjacent,	Adjac.
Admove,	Apply,	Admov.

Admoveantur,	Let (them) be applied,	Admov.
Admoveatur,	Let (it) be applied,	Admov.
Adstante febre,	The fever being on,	Adst. feb.
Adversum,	Against,	Adv.
Aggrediente febre,	While the fever is coming on,	Aggred. feb.
Agitato vase,	The vial being shaken,	Agit. vas.
Aliquot,	Some,	Aliq.
Alter,	The other,	Alt.
Alternis horis,	Every other hour,	Alt. hor.
Aluta,	Leather,	Aluta.
Alvo adstricta,	The bowels being confined,	Alv. adstr.
Alvus,	The belly,	Alv.
Amplus,	Large,	Amp.
Ampulla,	A large bottle,	Ampul.
Ana,	Of each,	A. or āā.
Aqua,	Water,	Aq.
Aqua astricta,	Frozen water,	Aq. astr.
Aqua bulliens,	Boiling water,	Aq. bull.
Aqua communis,	Common water,	Aq. com.
Aqua fervens,	Hot water,	Aq. ferv.
Aqua fluvialis or fluviatilis,	River water,	Aq. fluv.
Aqua fontalis,	Spring water,	Aq. font.
Aqua fontana or fontis,	Spring water,	Aq. font.
Aqua marina,	Sea water,	Aq. mar.
Aqua nivialis,	Snow water,	Aq. niv.
Aqua pluvialis or pluviatilis,	Rain water,	Aq. pluv.
Aquarius,	Pertaining to water,	Aquarius.
Aut,	Or,	Aut.
Balneum arenæ,	Sand-bath,	B. A.
Balneum mariae or maris,	Salt-water bath,	B. M.
Balneum vaporosum or vaporis,	Vapor-bath,	B. V.
Balsamum,	Balsam,	Bals.
Barbadensis,	Barbadoes,	B. B.
Bene,	Well,	Bene.
Bibe,	Drink (thou),	Bib.
Biduum,	Two days,	Bid.
Bis,	Twice,	Bis.
Bis in die or dies,	Twice a day,	Bis die.
Bolus,	A large pill,	Bol.
Bulliat or Bulliant,	Let boil,	Bull.
Bulliens,	Boiling,	Bull.
Butyrum,	Butter,	But.
Cæruleus,	Blue,	Cærul.
Calefactus,	Warmed,	Calef.
Calomel or Calomelas,	The mild chloride of mercury,	Cal.
Cape,	Take (thou),	Cap.
Capiat,	Let him take,	Cap.
Capsula,	A capsule,	Capsul.
Caute,	Cautiously,	Caute.

Charta,	Paper,	Chart.
Chartula,	A small paper,	Chartul.
Cibus,	Food,	Cib.
Cochlear, or Cochleare,	A spoonful (ʒj),	Coch.
Cochleare amplum,	A dessert-spoonful (ʒij),	Coch. amp.
Cochleare infantum,	A child's spoonful,	Coch. inf.
Cochleare magnum,	A table-spoonful (ℨss),	Coch. mag.
Cochleare medium or modicum,	A dessert-spoonful (ʒij),	Coch. med. or mod.
Cochleare parvum,	A tea-spoonful (ʒj),	Coch. parv.
Cochleatim,	By spoonfuls,	Cochleat.
Coctio,	Boiling,	Coct.
Cola,	Strain,	Col.
Colaturæ,	To the strained liquor,	Colatur.
Colatus,	Strained,	Colat.
Coletur,	Let it be strained,	Colet.
Colentur,	Let them be strained,	Colent.
Collutorium,	A mouth-wash,	Collut.
Collyrium,	An eye-wash,	Collyr.
Coloretur,	Let it be colored,	Coloret.
Compositus,	Compound,	Comp.
Concisus,	Cut,	Concis.
Confectio,	Confection,	Conf.
Congius,	A gallon,	Cong.
Conserva,	A conserve, also Keep (thou),	Cons.
Continuantur remedia,	Let the medicines be continued,	Cont. rem.
Continueter,	Let it be continued,	Cont.
Contusus,	Bruised,	Contus.
Coque ad medietatis consumptionem,	Boil to the consumption of half,	Coq. ad Med. Consump.
Coque, Coquantur,	Boil, let them be boiled,	Coq.
Coque in sufficiente quantitate aquæ,	Boil in sufficient water,	Coq. in S. A.
Coque secundum artem,	Boil according to art,	Coq. S. A.
Cor, Cordis,	The heart,	Cor.
Cornu cervi,	Hartshorn,	C. C.
Cortex, Corticis,	The bark,	Cort.
Coxa,	The hip,	Cox.
Cras,	To-morrow,	Cras.
Cras mane sumendus,	To be taken to-morrow morning,	Cras mane sumend.
Cras nocte,	To-morrow night,	Cras nocte.
Cras vespere,	To-morrow evening,	Crasp vest.
Crastinus,	To-morrow,	Crast.
Cujus, Cujus-libet,	Of which, Of any,	Cuj.
Cum,	With,	C.
Cyatho theæ,	In a cup of tea,	Cyatho theæ.
Cyathus, or Cyathus vinarius,	A wine-glass (ʒj–ij),	Cyath., C. vinar.
Da, detur,	Give, let it be given,	D., det.
De,	Of, or from,	De.
Deaurentur pilulæ,	Let the pills be gilded,	Deaur. pil.
Debita spissitudo,	A proper consistence,	Deb. spiss.

Debitus,	Due, proper,	Deb.
Decanta,	Pour off,	Dec.
Decem, Decimus,	Ten, the tenth,	Decem, Decim.
Decoctum,	A decoction,	Decoct.
Decubitus,	Lying down,	Decub.
De die in diem,	From day to day,	De d. in d.
Deglutiatur,	Let be swallowed,	Deglut.
Dein vel Deinde,	Thereupon,	Dein.
Dejectiones alvi,	Stools,	Dej. alv.
Detur in duplo,	Let twice as much be given,	Det. in dup.
Dexter, Dextra,	The right,	Dext.
Diebis tertiis,	Every third day,	Dieb. tert.
Diebus alternis,	Every other day,	Dieb. alt.
Digeratur,	Let it be digested,	Dig.
Diluculo,	At break of day,	Diluc.
Dilue, Dilutus,	Dilute (thou), Diluted,	Dil.
Dimidius,	One half,	Dim.
Directione propriâ,	With a proper direction,	D. P. or Direct prop.
Dividatur in partes æquales,	Let it be divided into equal parts,	D. in p. æq.
Dividendus, -a, -um,	To be divided,	Divid.
Dolor,	Pain,	Dolor.
Donec,	Until,	Donec.
Donec alvus bis dejeciatur,	Until the bowels have been twice evacuated,	Donec alv. bis. dejic.
Donec alvus soluta fuerit,	Until the bowels shall be opened,	Donec alv. sol. ft.
Donec dolor nephriticus exulaverit,	Until the nephritic pain is removed,	Donec dolor. neph. exulav.
Dosis,	A dose,	D.
Drachma,	A drachm (60 grains),	Dr. or ʒ.
Durante dolore,	While the pain lasts,	Dur. dolor.
Eadem (fem.),	The same,	Ead.
Eburneus,	Made of ivory,	Eburn.
Ejusdem,	Of the same,	Ejusd.
Electuarium,	An electuary,	Elect.
Emesis,	Vomiting,	Emesis.
Enema,	A clyster or enema,	En.
Enemata,	Clysters,	Enem.
Et,	And,	Et.
Evanuerit,	Shall have disappeared,	Evan.
Exhibeatur,	Let it be exhibited,	Exhib.
Extende,	Spread,	Ext.
Extende super alutam mollem,	Spread upon soft leather,	Ext. sup. alut. moll.
Extractum,	An extract,	Extr.
Fac,	Make,	F.
Fac cataplasmatem,	Make a poultice,	F. cataplasm.
Fac pilulas duodecim,	Make 12 pills,	F. pil. xij.
Farina,	Flour,	Farina.
Fasciculus,	A small bundle,	Fasc.
Febre durante,	During the fever,	Febr. dur.
Febris,	Fever,	Febr.

Femoribus internis,	To the inner thighs,	Feb. intern.
Fervens,	Boiling,	Ferv.
Fiant,	Let them be made,	Ft.
Fiant chartulæ xij,	Let 12 powders be made,	Ft. chart. xij.
Fiant pilulæ xij,	Let 12 pills be made,	Ft. pil. xij.
Fiant pulveres xij,	Let 12 powders be made,	Ft. pulv. xij.
Fiant suppositoria iv,	Let 4 suppositories be made,	Ft. suppos. iv.
Fiant trochisci xxiv,	Let 24 troches be made,	Ft. troch. xxiv.
Fiat,	Let it be made,	Ft.
Fiat ceratum,	Let a cerate be made,	Ft. cerat.
Fiat collyrium,	Let an eye-wash be made,	Ft. collyr.
Fiat emplastrum vesicatorium,	Let a blister be made,	Ft. emp. vesic.
Fiat emulsio,	Let an emulsion be made,	Ft. emuls.
Fiat enema,	Let an enema (an injection for the rectum) be made,	Ft. enem.
Fiat injectio,	Let an injection (for the urethra) be made,	Ft. inject.
Fiat lege artis,	Let it be made by the rules of art,	F. L. A.
Fiat massa, et divide in pilulas xij,	Let a mass be made, and divide it into 12 pills,	Ft. mas. div. in pil. xij.
Fiat pulvis,	Let a powder be made,	Ft. pulv.
Fiat pulvis in chartulas xij dividenda,	Let a powder be made to be divided into xij little papers,	Ft. pulv. in chart. xij, div.
Fiat solutio,	Let a solution be made,	Ft. sol.
Fiat unguentum,	Let an ointment be made,	Ft. ung.
Fiat venesectio,	Let a bleeding be done,	Ft. venesec.
Fictilis,	Earthen,	Fict.
Filtra,	Filter (thou),	Filtra.
Filtrum,	A filter,	Filt.
Fistula armata,	A syringe ready for use,	Fistul. arm.
Flores,	Flowers,	Fl.
Fluidus,	Liquid,	Fluid., Fl.
Formula,	A prescription,	Form.
Frustillatim,	In small pieces,	Frust.
Fuerit,	Shall have been,	Fuerit.
Gargarisma,	A gargle,	Garg.
Gelatina quavis,	In any kind of jelly,	Gelat. quav.
Gradatim,	By degrees, gradually,	Grad.
Gramme,	Gram,	Gm.
Grana sex pondere,	Six grains by weight,	Gran. vj, pond.
Granum, Grana,	Grains, Grains,	Gr.
Gratus,	Pleasant,	Grat.
Gummi guttæ gambiæ,	Gamboge,	G. G. G.
Gutta, Guttæ,	A drop, Drops,	Gtt.
Guttatim,	By drops,	Guttat.
Guttis quibusdam,	With a few drops,	Gtt. quibusd.
Harum pilularum summantur tres,	Let three of these pills be taken,	Har. pil. sum. iij.
Haustus,	A draught,	Haust.
Haustus purgans noster,	A purgative draught after my own (formula),	H. p. n.

Hebdomada,	A week,	Hebdom.
Herba,	An herb,	Herb.
Herbarum recentium,	Of fresh herbs,	Herb. recent.
Heri,	Yesterday,	Heri.
Hic, Haec, Hoc,	This,	Hic, Haec, Hoc.
Hirudo,	A leech,	Hirudo.
Hora,	An hour,	H.
Horâ decubitus,	At bedtime,	Hor. decub.
Horâ somni,	At the hour of sleep,	Hor. som.
Horâ undecimâ matutinâ,	At the eleventh hour of the morning,	Hor. xj, matut.
Horæ unius spatio,	For the space of one hour,	Hor. j, spat.
Horis intermediis,	In the intermediate hours,	Hor. intermed.
Idem,	The same,	Id.
Idoneus,	Proper,	Idon.
Imprimis,	First,	Impr.
Incide, Incisus,	Cut (thou), Being cut,	Inc.
Indies,	Daily, or From day to day,	Ind.
Infunde,	Pour in,	Infun.
Infusum,	An infusion,	Infus.
Injectio,	An injection,	Injec.
Injiciatur enema,	Let a clyster be given,	Injic. enem.
In pulmento,	In gruel,	In pulm.
Instar,	Like,	Instar.
Inter,	Between,	Inter.
Internus, -a,- um,	Inner, or Internal,	Int.
Intus,	Inwardly,	Intus.
Jam,	Now,	Jam.
Julepus, Julepum, Julapium,	A julep,	Jul.
Jusculum,	A broth,	Jusc.
Juxta,	Near to,	Juxta.
Kali præparatum,	Prepared potash, or potassium carbonate.	Kal. ppt.
Lac, Lactis,	Milk, of Milk,	Lac.
Lagena,	A flask or bottle,	Lag.
Lana,	Flannel, Wool,	Lana.
Languor,	Faintness,	Lang.
Lateri dolenti,	To the painful side,	Lat. dol.
Lectus,	A bed,	Lect.
Libra,	A pound,	Lb. or ℔.
Libræ,	Pounds,	Lib. or Llb.
Linimentum,	A liniment,	Linim.
Linteum,	Lint,	Lint.
Liquor,	A solution,	Liq.
Lotio,	A lotion,	Lot.
Macera,	Macerate,	Mac.
Magnus,	Large,	Mag.
Mane,	In the morning,	Mane.
Mane primo,	In the very early morning,	Mane primo.
Manipulus,	A handful,	M. or Man.
Manus,	The hand,	Manus.
Massa,	A mass or pill-mass,	Mass.
Matutinus,	In the morning,	Matut.

Medius,	Middle,	Med.
Mensura,	By measure,	Mensur.
Mica panis,	Crumb of bread,	Mic. pan.
Minimum,	A minim,	♏ or Min.
Minutum,	A minute,	Minut.
Misce,	Mix,	M.
Mistura,	A mixture,	Mist.
Mittatur,	Let (it) be sent,	Mit.
Mittantur,	Let (them) be sent,	Mit.
Mitte,	Send,	Mit.
Mitte sanguinem ad uncias duodecim saltem,	Take away blood to 12 ounces, at least,	Mit. sang. ad uncias xij, salt.
Modicus,	Middle-sized,	Modic.
Modo præscripto,	In the manner prescribed,	Mod. præsc.
Mora,	Delay,	Mora.
More dictu,	In the manner directed,	Mor. dict.
More solito,	In the usual manner,	Mor. sol.
Morturarium,	A mortar,	Mort.
Nec-non,	Also,	Necn.
Ne trades sine nummo,	Do not deliver without the money,	Ne. tr. s. num.
Nisi,	Unless,	Nisi.
Nocte maneque,	At night and in the morning,	Noct. maneq.
Non,	Not,	Non.
Non repetatur,	Let it not be repeated,	Non repetat.
Nox, Noctis,	The night, of the Night,	Nox, Noct.
Nucha,	The nape of the neck,	Nucha.
Numero,	In number,	No.
Numerus,	Number,	No.
Nux moschata,	A nutmeg,	Nux mosch.
Octarius,	A pint (℥xvj),	O., Oct.
Octavus,	Eighth,	Octav.
Octo,	Eight,	Octo.
Oleum lini sine igne,	Cold-drawn linseed oil,	Ol. lini sine ig.
Oleum olivæ optimum,	Best olive oil,	Ol. O. opt.
Omni biduo,	Every two days,	Omn. bid.
Omni bihorio,	Every two hours,	Omn. bih.
Omni horâ,	Every hour,	Omn. hor.
Omni mane,	Every morning,	Omn. mane.
Omni nocte,	Every night,	Omn. noct.
Omni quadrante horæ,	Every quarter hour,	Omn. quadr. hor.
Opus,	Need or occasion,	Opus.
Ovum,	An egg,	Ov.
Pannus,	A rag,	Pan.
Pars, Partis,	A part, of a Part,	Par., Pt.
Partes æquales,	Equal parts,	Pt. æq.
Partitis vicibus,	In divided doses,	Part. vic.
Parvulus,	An infant, A parvule,	Parvul.
Parvus,	Little,	Parv.
Pastillus, Pastillum,	A pastille,	Pastil.
Pediluvium,	A foot-bath,	Pediluv.

Penicillum camelinum,	A camel's-hair pencil or brush,	Penic. cam.
Per,	Through, By,	Per.
Per deliquium,	By deliquescence,	Per deliq.
Per fistulam vitream,	Through a glass tube,	Per fist. vit.
Peracta operatio emetici,	When the action of the emetic is finished,	Peract.operat.emet.
Pergo, Pergere,	To go on with,	Perg.
Phiala,	A vial or bottle,	Phi.
Phiala prius agitata,	The bottle having been first shaken,	P. P. A.
Pilula,	A pill,	Pil.
Pocillum,	A little cup,	Pocill.
Poculum,	A cup,	Pocul.
Pondere,	By weight,	P.
Pondus civile,	Civil weight (avoirdupois),	P. civ.
Pondus medicinale,	Medicinal weight,	P. med.
Pone aurem,	Behind the ear,	Pone aur.
Post singulas sedes liquidas,	After every loose stool,	Post sing. sed. liq.
Potus,	Drink,	Potus.
Præparata,	Prepared,	Præp.
Primo mane,	Very early in the morning,	Primo mane.
Primus,	The first,	Primus.
Pro,	For,	Pro.
Pro ratione ætatis,	According to the age of the patient,	Pro rat. æt.
Pro re nata,	Occasionally, According to circumstances,	P. r. n.
Pugillus,	A pinch,	Pug.
Pulmentum,	Gruel,	Pulm.
Pulverizatus,	Powdered,	Pulvz.
Pulvis,	A powder,	Pulv.
Pulvis patrum,	Jesuits' bark,	P. P.
Pyxis,	A pill-box,	Pyxis.
Quadrans, Quadrantis,	A quart,	Quad.
Quantum libet,	As much as you please,	Q. lib.
Quantum placet,	" " " "	Q. p.
Quantum satis,	As much as is sufficient,	Q. s.
Quantum sufficiat,	" " " "	Q. s.
Quantum vis,	As much as you please,	Q. v.
Quantum volueris,	" " " "	Q. vol.
Quâquâ horâ,	Every hour,	Qq. hor.
Quaque,	Each, or Every,	Qq.
Quartus,	Fourth,	Quart.
Quater,	Four times,	Quater.
Quatuor,	Four,	Quat.
Quibus,	From which,	Quibus.
Quinque,	Five,	Quinq.
Quintus,	The fifth,	Quint.
Quoque,	Also,	Q. q.
Quorum,	Of which,	Quor.
Quotidie,	Daily,	Quotid.
Rasuræ,	Shavings,	Ras.

Ratio,	Proportion,	Ratio.
Recens, Recentis,	Fresh,	Rec.
Recipe,	Take,	℞.
Rectificatus,	Rectified,	Rect.
Redactus in pulverem,	Reduced to powder,	Red. in pulv.
Redigatur in pulverem,	Let it be reduced to powder,	Redig. in pulv.
Regio umbilici,	The umbilical region,	Reg. umbil.
Reliquus,	Remaining,	Reliq.
Repetantur,	Let them be repeated,	Rept.
Repetatur,	Let it be repeated,	Rept.
Respondere,	To answer,	Respond.
Retinere,	To keep,	Retin.
Saltem,	At least,	Saltem.
Saturatus, -a, -um,	Saturated,	Sat.
Scatula,	A box,	Scat.
Scilicet,	Namely,	Scil.
Scrupulum,	A scruple (20 grains),	Scrup. or ℈.
Secundum artem,	According to art,	S. A.
Secundum naturam,	According to nature,	S. N.
Secundus,	Second,	Secund.
Sedes,	The alvine evacuation,	Sed.
Semel,	Once,	Semel.
Semi-drachma,	Half a drachm,	Semidr.
Semi-hora,	Half an hour,	Semih.
Semis, or Semissis,	A half,	Ss.
Septem,	Seven,	Sept.
Septimana,	A week,	Septim.
Sescuncia,	An ounce and a half,	Sescunc.
Sesquihora,	An hour and a half,	Sesquih.
Sex,	Six,	Sex.
Sextus,	Sixth,	Sext.
Si,	If,	Si.
Si non valeat,	If it does not answer,	Si non val.
Si opus sit,	If necessary,	Si op. sit.
Si vires permittant,	If the strength will bear it,	Sir. vir. perm.
Signa,	Write, or Mark (thou),	Sig.
Signatur nomine proprio,	Let it be written upon with its proper name,	Sig. nom. prop.
Simul,	Together,	Simul.
Sine,	Without,	Sin.
Singularum,	Of each,	Sing.
Singulorum,	Of each,	Sing.
Sit,	Let it be,	Sit.
Solus,	Alone,	Sol.
Solutus,	Dissolved,	Solut.
Solve,	Dissolve,	Solv.
Solvo, Solvere,	I dissolve, To dissolve,	Solv.
Somnus,	Sleep,	Somnus.
Spiritus, -ûs,	Spirit,	Spt.
Spiritus vini rectificatus,	Rectified spirit of wine (*i. e.* alcohol),	Spt. vin. rect.
Spiritus vini tenuis,	Proof spirit,	Spt. vin. ten.

Spiritus vinosus,	Ardent spirit (of any strength),	Spt. vinos.
Statim,	Immediately,	Stat.
Stet, or Stent,	Let it (or them) stand,	St.
Stratum superstratum,	Layer upon layer,	S. S. S.
Sub finem coctionis,	When the boiling is nearly finished,	Sub. fin. coct.
Subactus,	Subdued,	Subact.
Subinde,	Frequently,	Subind.
Sumantur,	Let them be taken,	Sum.
Sumat,	Let him take,	Sum.
Sumat talem,	Let him take one like this,	Sum. tal.
Sumatur,	Let it be taken,	Sum.
Sume,	Take,	Sume.
Sumendus,	To be taken,	Sum.
Summitates,	The summits,	Summit.
Superbibendo haustum,	Drinking afterward this draught,	Sup. bib. haust.
Supra,	Above,	Supra.
Syrupus, Syrupi,	Syrup,	Syr.
Tabella,	A lozenge,	Tab.
Talis,	Such a one,	Tal.
Tempori dextro,	To the right temple,	Tempor. dext.
Tempus, Temporis,	Time, or Temple,	Temp.
Ter,	Thrice, or Three times,	Ter.
Ter in die, or Ter die,	Thrice daily,	T. i. d., or T. d.
Tere,	Rub,	Tere.
Tere simul,	Rub together,	Tere. sim.
Tero,	I rub,	Tero.
Tertius,	Third,	Tert.
Tinctura,	Tincture,	Tinct. or Tr.
Tincturæ Herbarum Recentium,	Tinctures of fresh herbs,	Tinct. Herb. Recent.
Tres,	Three,	Tres.
Triduum,	Three days,	Trid.
Tritura,	Triturate,	Trit.
Trochiscus, Trochisci,	A lozenge or troche, Lozenges or troches,	Troch.
Tussis,	A cough,	Tus.
Ultimo (or Ultima) præscriptus,	The last ordered,	Ult. præsc.
Una,	Together,	Una.
Uncia,	An ounce,	Unc. or ℥.
Usque ad deliquium,	To fainting,	Usq. ad deliq.
Ut dictum,	As directed,	Ut dict.
Utendum,	To be used,	Utend.
Uto, Uti,	I use, To use,	Uto, Uti.
Vas vitreum,	A glass vessel,	Vas vit.
Vehiculum,	A vehicle or menstruum,	Vehic.
Vel,	Or,	Vel.
Venæsectio brachii,	Bleeding in the arm,	Venæsec. brach.
Vesper, Vesperis,	The evening,	Vesp.
Vices,	Turns,	Vic.

Vinum,	Wine,	Vin.
Vires,	Strength,	Vir.
Vitello ovi Solutus,	Dissolved in the yolk of an egg,	Vitel. ovi Sol.
Vitellus,	Yolk,	Vitel.
Vitellus ovi,	Yolk of an egg,	Vitel. ovi.
Vitreum, Vitrum,	Glass,	Vitr.
Vomitione urgente,	Vomiting being severe,	Vom. urg.

The arrangement of the various classes of preparations used in prescriptions has an important bearing in presenting to the mind of the reader a consistent sequence, and it is believed that the classification used by the author in his work *The Practice of Pharmacy* (1900, 3d ed.), and shown separately on page 283 of that work, is also well adapted for use in this SYSTEM OF THERAPEUTICS. Of course the scope of the present article precludes the possibility of entering into such minute observations as would only be of interest to a pharmacist, but in the consideration of the various preparations which follow sufficient information must be given of pharmaceutical operations to convey to those who are unskilled in the mysteries of the ancient art a fair conception of the processes which furnish the preparations; this much being assumed, however, that all who use this work have previously had some knowledge of pharmacy, the tendency of all modern medical education being to recognize that advances in therapeutics go hand in hand with progress in pharmacy and the elevation of both professions.

The classification referred to above first divides all official preparations into two classes—*liquids* and *solids.* Liquids are arranged according to the relative solubility of the substance in the solvent selected, the character of the solvent aiding also in the classification; simple solvents, as water, syrup, alcohol, glycerin, etc., holding the first rank. The process of percolation which is now universally used in America divides pharmaceutical preparations very naturally into classes, and as it involves only *partial solution* (the larger portion of inert matter in drugs, the ligneous fibre, being rejected), preparations in which *solution is complete* or nearly so should have the first place, because the principles involved are simpler and more direct. With these views as a guide, the first preparations to consider are the official aqueous solutions (waters and solutions and aqueous solutions containing sweet or viscid substances), then in succession liquid preparations made by solution with alcohol, ether, oils, and oleic acid as solvents; the second sub-class introduces the preparations made by percolation or maceration, and here the same order is observed: first, those made with water as a menstruum and water containing acid (infusions and decoctions and vinegars); then alcoholic percolates (tinctures, wines, and

fluid extracts), followed by ethereal preparations and the oleoresins. This completes the first division, and the solids are now considered, the first of this class being those made by the evaporation or precipitation of the percolates of the first class, and thus the sequence is maintained. The last sub-class is composed of solids made without percolation or maceration, and under this head are grouped all of the solid preparations usually made extemporaneously.

Liquids.

Aqueous Solutions.

Aquæ (Waters).—Waters, or medicated waters of the Pharmacopœia, are aqueous solutions of volatile substances, and are almost exclusively used as solvents or pleasant vehicles for the administration of various medicines. They are prepared in several different ways:

Firstly, by simple solution, agitating the volatile liquid with water until dissolved, and if necessary filtering the solution. Bitter-almond-water and creasote-water are thus prepared.

In the case of solutions of gases, the gases, after being generated in suitable apparatus, are passed through water until solutions of the proper strength are obtained.

Ammonia water, stronger ammonia water, solution of hydrogen dioxide, and chlorine-water are prepared in this manner.

Secondly, by percolating water through oil which has previously been thoroughly distributed through an absorbent powder. The following waters are thus prepared: viz. anise-water, camphor-water, cinnamon-water, fennel-water, peppermint-water, and spearmint-water.

This process was replaced in the Pharmacopœia of 1880 by the cotton process, which was found unsatisfactory. The best process consists in thoroughly mixing the oil with magnesium carbonate and water, and then filtering the solution through paper: the object of using the magnesium carbonate was to divide the oil thoroughly, and thus expose a greater surface to the action of the water, by which means it became completely saturated.

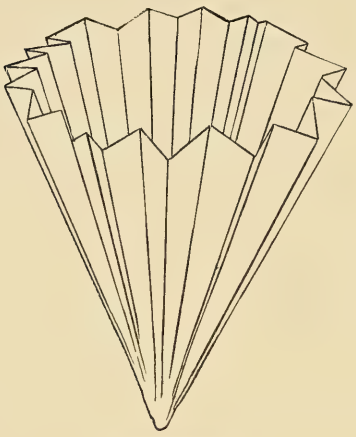
Notwithstanding the change made by the U. S. P., 1880—which perhaps was not an improvement—it is feared that the great majority of pharmacists throughout the country did not follow the official directions, but adhered to the old method of using the magnesium carbonate. The use of magnesium carbonate was objected to on account of its slight solubility, which unfitted the water thus made for preparing certain solutions, as, for example, solution of silver nitrate, where a slight decomposition would take place; for making such solutions, however, distilled water should at all times be used.

Instead of using magnesium carbonate to diffuse the volatile oil,

many other substances have been proposed and used, such as magnesia, precipitated calcium phosphate (see U. S. P., 1890), porcelain clay, powdered silica, finely-powdered glass, powdered pumice-stone, powdered talcum or soapstone, etc.: none of these substances, however, are superior to magnesium carbonate.

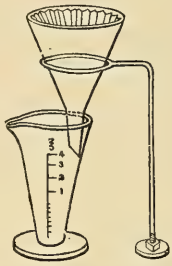
The process of filtration, so frequently performed by the pharmacist, is effected by folding bibulous paper, made especially for the purpose and termed filtering-paper, into a conical shape, as seen in Fig. 2, and then placing the filter in a funnel, moistening or washing the filter by pouring

Fig. 2.



Plaited Filter.

Fig. 3.



Arrangement of Funnel in Filtration.

water through it, and then pouring into the filter the liquid which is to be made transparent. The clear liquid flowing from the filter is termed the *filtrate*.

Fig. 3 shows a good method of supporting a funnel and filter during filtration, the end of the funnel touching the side of the graduate to prevent splashing.

Another unofficial method of making medicated waters which has been tried and recommended is that of using hot water in making the solutions. This method is founded on the fact that most of the volatile oils are much more soluble in hot than in cold water. By this plan the volatile oil is agitated with hot water in a metallic vessel or bottle until the water becomes saturated, and after standing until the oil separates, the water is separated from the excess of oil and filtered.

In prescribing, saturated solutions of salts should not be made with the medicated waters, for the reason that the waters being themselves saturated solutions, the various volatile substances from which they are prepared, not being so soluble in saturated solutions as they are in water, are precipitated, thus disturbing the transparency of the solution.

Take, for example, the following prescription:

℞.
Potassii bromidi, ʒvj ;
Aquæ camphoræ, q. s. ut ft. fʒij.
M. ft.

From this solution a portion of the camphor is precipitated, thus making an inelegant and unsightly preparation. The careful pharmacist, having prepared such a solution, would probably filter it ; this would remove the precipitated camphor, but the quantity thus removed would not be enough to make any appreciable difference either in the taste or in the dose. This difficulty may be avoided by using equal parts of water and camphor-water to make the solution.

The following prescriptions show the use of medicated waters as vehicles and solvents :

℞.
Sodii bicarb., ʒij ;
Spt. ammon. arom., fʒss ;
Syrupi, fʒj ;
Aq. menth. virid., fʒiij ;
M. Ft. in solutio.
Sig. Soda mint. A table-spoonful 3 times a day.
T. U. T.

℞.
Potassii iodidi, ʒijss ;
Syr. aurantii, fʒiij ;
Aq. cinnamom., fʒiij.
M. Ft. in solutio.
Sig. A tea-spoonful 4 times a day.
T.

℞.
Antipyrin., ʒj ;
Syrupi, fʒss ;
Aq. carui, ad fʒij.
M. Ft. in solutio.
Sig. One tea-spoonful every hour, as directed. W.

℞.
Sodii salicylat., ʒj ;
Syrupi, fʒj ;
Aquæ menth. pip., ad fʒiij.
M. Ft. in solutio.
Sig. Two tea-spoonfuls every 3 hours. M. L. V.

Liquores (Solutions).—"Liquores" of the Pharmacopœia are aqueous solutions of substances entirely soluble in the solvent selected, exclusive of those coming under the definitions of Waters and Syrups. They may be separated into two classes—simple solutions in water, and those in which chemical action is involved in the solution. Most of them possess active medicinal properties, and some of them are poisons. There are twenty-four official solutions : four of them contain arsenic—namely, solution of arsenious acid, solution of potassium arsenite, solution of sodium arsenate, and solution of arsenic and mercuric iodide ; the arsenical strength of each of these is 1 per cent. Six of the "liquores" are used only externally : these are solution of mercuric nitrate, solution of lead subacetate, diluted solution of lead subacetate, solution of zinc chloride, and solution of sodium silicate.

The names of the other official solutions are as follows: solutions of ammonium acetate, lime, ferric acetate, ferric chloride, ferric citrate, ferric nitrate, ferric subsulphate, ferric sulphate, magnesium citrate, potassa, potassium citrate, soda, chlorinated soda, iron and ammonium acetate, and compound solution of iodine.

℞.

Hydrarg. iodid. rub., gr. xviij;
Potassii iodidi, gr. xiv;
Aq. destill., f℥iv.
Ft. solutio.

Sig. Channing's solution. Take five drops in water 3 times a day. W. V. K.

℞.

Morphinæ sulph., gr. j;
Aq. destill., f℥j.
M. Ft. in solutio.

Sig. A tea-spoonful at night. L. A. S.

Aqueous Solutions containing Sweet or Viscid Substances.

Syrupi (Syrups).—Syrups are concentrated solutions of sugar in aqueous fluids; they are valuable preparations, being permanent when well made, their sweet taste rendering them acceptable to the palate and making them useful vehicles for the administration of many medicines.

A solution of sugar in water, of the proper strength, is called "syrupus" or syrup; other syrups take their names from the medicinal or flavoring substances from which they are prepared, and are known as medicated or flavoring syrups.

Medicated syrups are prepared from various liquids, such as infusions, decoctions, vinegars, solutions, etc., and are made in several different ways, depending in each case upon the physical condition, chemical composition, and other peculiarities of the substances employed.

Flavoring syrups are not medicinal in their action, but are used for flavoring drinks of various kinds, and are useful in disguising the taste of unpleasant medicines. They are prepared from fruits, and also from a variety of aromatic or pleasantly flavored substances.

There are thirty-two syrups official in the Pharmacopœia; in six of them the solution of sugar is effected by heat; these are "syrup," syrup of lime, syrup of raspberry, syrup of squill, syrup of ferrous iodide, and compound syrup of sarsaparilla.

In fifteen syrups the sugar is dissolved in the medicated liquids by agitation without heat; these are the syrups of almond, althæa, garlic, ginger, hydriodic acid, hypophosphites, hypophosphites with iron, calcium lactophosphate, orange, orange-flowers, the phosphates of iron, quinine, and strychnine, senega, senna, wild-cherry, and compound syrup of squill.

Ten of the syrups are prepared by mixing the medicating sub-

stances with the syrup; they are as follows: aromatic syrup of rhubarb, syrups of acacia, citric acid, ipecac, krameria, lactucarium, rose, rubus, tolu, and rhubarb. One syrup (the syrup of tar) is made by digestion. Syrups should not be prescribed with strong alcohol, for the sugar may be thrown out of solution and precipitated, or it may crystallize out on standing.

Herewith are presented a few prescriptions illustrating the use of syrups:

℞.
Acid. phosph. dil., fʒiv;
Syr. aurant. flor., fʒiss.
Ft. solutio.
Sig. Two tea-spoonfuls in water 3 times a day. N. L.

℞.
Quinin. sulph., ʒss;
Aq. ammon., gtt. iij;
Syr. glycyrrhizæ, fʒij.
Fiat mistura.
Sig. Shake the bottle and take a tea-spoonful twice a day. T. R.

℞.
Sodii brom., ʒss;
Chloral. hydrat., ʒiiss;
Syr. aurantii flor., fʒss;
Aquæ, q. s. ft. fʒij.
Ft. solutio.
Sig. A dessert-spoonful at night in water.

℞.
Tinct. ferri chlor.,
Acid. phosph. dil., āā. fʒj;
Syr. limon., fʒiv.
Ft. solutio.
Sig. A dessert-spoonful in water after meals. I. F. G.

℞.
Hydrarg. chlor. cor., gr. j;
Liq. arsen. chlor., fʒj;
Tinct. ferri chlor.,
Acid. hydrochl. dil., āā. fʒiv;
Syr. zingiber., fʒiij;
Aquæ, q. s. ft. fʒvj.
Ft. solutio.
Sig. A dessert-spoonful in water after meals. A. H. S.

℞.
Antipyrin., ʒj;
Syr. tolut., fʒij.
Ft. solutio.
Sig. A dessert-spoonful in water every 2 hours until relieved. V.

Mellita (Honeys).—Honey is a secretion deposited by the well-known honey-bee. It has no special medicinal value, but its pleasant taste and demulcent properties render it a pleasant vehicle for mixtures and gargles, and useful as an excipient, for which purposes, after having been clarified, it is used in the official preparations containing it—honey of rose, confection of rose, and the mass of ferrous carbonate.

℞.

Pulv. alumin.,	gr. xx ;
Mel. rosæ,	fʒj.
Ft. solutio.	

Sig. Apply to the sore mouth as directed. M. T.

℞.

Sodii bor.,	gr. xx ;
Mel. despum.,	fʒj.
Ft. solutio.	

Sig. Use as directed. N. L.

Mucilagines (Mucilages).—Mucilages are solutions in water of the gummy or mucilaginous principles of vegetable substances. They are not permanent preparations, and should not be prepared in large quantities. In pharmacy, mucilages are used as demulcents either internally or externally, as eye-washes, as excipients, and as vehicles for the administration of various remedies. There are four mucilages official, those of acacia and sassafras-pith being made with cold water, while those of elm and tragacanth are made with boiling water. The mucilages of acacia and of tragacanth, if not to be used for medicinal purposes, may be rendered more permanent by the addition of a small portion of creasote, volatile oil, or a trace of formaldehyde.

℞.

Ol. terebinth.,	ʒj ;
Pulv. sacch. alb.,	gr. xxx ;
Muc. acaciæ,	fʒss ;
Aquæ, q. s. ft.	fʒiv.
Ft. mistura.	

Sig. A tea-spoonful 3 times a day.

℞.

Copaibæ,	fʒss ;
Liq. potassæ,	fʒij ;
Spt. æth. nit.,	fʒj ;
Tinct. opii,	fʒij ;
Muc. acaciæ,	fʒiv.
Ft. mistura.	

Sig. A tea-spoonful 3 times a day. F. F. M.

Misturæ (Mixtures).—Mixtures are aqueous preparations in which insoluble materials are mechanically suspended. Under this heading the Pharmacopœia formerly included mixtures containing oleaginous matters, which, being distinctive, should be separated from mixtures and classified under the title "Emulsions." The term "mixture" is frequently applied, but pharmaceutically incorrectly so, to perfect solutions where two or more ingredients are mixed together. The special purpose of mixtures is to disguise the taste of unpleasant remedies or to facilitate their admininistration, the vehicle used being generally of a syrupy or mucilaginous character, whereby the insoluble substances are held in suspension. Mixtures are mostly extemporaneous preparations, and cannot be kept long ; they should therefore be made in only such quantities as are immediately wanted.

The official mixtures are as follows : chalk, compound iron, com-

pound mixture of glycyrrhiza, and rhubarb and soda. The mixture of acetate of iron and ammonium was formerly improperly named; it, being a perfect solution, is now classed among the "Liquores," while, as we have said before, the following mixtures are named emulsions: viz. almond, ammoniac, asafetida, and chloroform. This last-named substance, not being oily in its character, is nevertheless best made into an emulsion by means of the yolk of egg. Emulsions are prepared by making a thick mucilage of acacia with water, and then very slowly and gradually introducing the oily substance to be emulsified, stirring constantly with a light motion, without using pressure (see Fig. 4), the object being to entangle the globules of oil and envelop each one with a thin layer of mucilage; these enveloped globules float in the water, and then resemble closely the type of all emulsions, cow's milk or cream.

Fig. 4.

Emulsion Mortar and Pestle.

The following are illustrations of methods of prescribing mixtures:

℞.

Res. guaiaci,	gr. xlv;
Pulv. acaciæ,	
Pulv. sacch. alb.,	āā. gr. xl;
Aq. cinnamomi,	f℥iv.
Ft. mistura.	

Sig. A tea-spoonful 3 times a day.

N. G. W.

℞.

Ol. picis liq.,	f℥j;
Chloroform.,	♏xx;
Ol. menth. pip.,	♏v;
Pulv. ext. glycyrrh.,	ʒij;
Pulv. sacch. alb.,	℥j;
Alcoholis,	f℥ss;
Acaciæ,	q. s.
Aquæ, q. s. ft.	f℥iv.
M. Ft. mistura.	

Sig. A tea-spoonful 3 times a day.

W. K. T.

Glycerita (Glycerites).—Glycerites are mixtures or solutions of medicinal substances made with glycerin. Only two are not clear solutions—the glycerite of starch, which is made by first mixing thoroughly starch and glycerin, and afterward heating the mixture until the starch-granules are completely dissolved; and the glycerite of yolk of egg, which is made by rubbing the two ingredients together until thoroughly mixed. Possessing demulcent and emollient properties, both of them are used as protective local applications

to irritated surfaces, while the glycerite of yolk of egg has been recommended as a basis for emulsionizing cod-liver and other oils.

Glycerites of carbolic acid, boroglycerin, hydrastis, and tannic acid are transparent liquids, and are valuable additions to the glycerites of the U. S. P., 1890:

℞.

Boroglycerid.,	f℥ij;
Glycerini,	f℥vj.
Ft. solutio.	

Sig. Apply as directed. V. T.

℞.

Acidi tannici,	℥j;
Glycerini,	f℥ss.
Ft. solutio.	

Sig. Use as directed. M. L.

℞.

Ol. morrhuæ,	f℥j;
Spt. frumenti,	f℥ss;
Glycerit. vitelli,	f℥iss;
Ft. emulsio.	

Sig. A table-spoonful after meals. W. N. H.

℞.

Ext. belladon.,	gr. xij;
Ext. opii,	gr. vj;
Glycerit. amyli,	℥ss.
Ft. unguentum.	

Sig. Use as directed. E. W.

Alcoholic Solutions.

Spiritus (Spirits).—"Spirits" of the Pharmacopœia are alcoholic or hydro-alcoholic solutions of volatile substances, and are prepared either by solution or distillation.

The principal use of the aromatic spirits is to give agreeable taste and flavor to medicines of various kinds or to correct their nauseating or griping tendencies.

Spirits should not be prescribed with aqueous mixtures without carefully considering the relative quantities of each, or the oily substance will be apt to be thrown out of combination; the addition of gum or other emulsionizing substance is then proper to prevent separation at the time of administering.

Nearly all of the official spirits are made by solution, only one (the spirit of nitrous ether) being made by chemical action and two (brandy and whiskey) by distillation. The other official spirits are as follows: spirits of ammonia, anise, bitter almond, camphor, chloroform, cinnamon, ether, gaultheria, juniper, lavender, lemon, myrcia, nitroglycerin, nutmeg, orange, phosphorus, peppermint, and spearmint; aromatic spirit of ammonia, compound spirits of ether, orange, and juniper. The following prescriptions illustrate various methods of administering spirits:

℞.

Potassi acet.,	ʒij ;
Spt. junip. comp.,	fʒiv ;
Spt. æth. nit.,	fʒj ;
Infus. scoparii,	fʒiv.

Ft. solutio.

Sig. Two table-spoonfuls thrice daily. W. H. D.

℞.

Chloroformi,	
Spt. ammon. arom.,	āā. fʒiv ;
Tinct. opii camph.,	
Spt. ætheris comp.,	āā. fʒj ;
Ovi vitelli,	j.

Ft. mistura.

Sig. A tea-spoonful as required. E. H.

℞.

Spt. chloroformi,	
Tinct. card. comp.,	āā. fʒij.

Sig. A tea-spoonful every half hour until relieved. B.

℞.

Morph. sulph.,	gr. iss ;
Ext. cannabis,	gr. x ;
Spt. ammon. arom.,	♏ xx ;
Spt. ætheris,	fʒj ;
Spt. gaultheriæ,	fʒiss.

Ft. solutio.

Sig. Half a tea-spoonful at night. W. W.

℞.

Spt. camphoræ,	fʒj ;
Lin. saponis,	fʒiij ;

Ft. linimentum.

Sig. Use as directed. L. E. A.

℞.

Bismuth. subnit.,	ʒj ;
Cretæ præparatæ,	ʒij ;
Spt. menth. vir.,	fʒij ;
Syrupi,	fʒiv ;
Aquæ, q. s. ft.	fʒiv.

Ft. mistura.

Sig. A tea-spoonful every 4 hours. M.

Elixiria (Elixirs).—Elixirs are liquid preparations containing sugar and alcohol, usually combined with aromatics, and generally not possessing much medicinal activity, their particular object being to disguise or render pleasant to the taste medicines otherwise disagreeable. Of late years they have been very extensively used, being pleasing to the eye as well as fragrant and palatable.

Only one elixir is official in the Pharmacopœia, although in the National Formulary no less than eighty-six formulas are given, many of which, though used in some parts of the country, contain substances which are totally unfitted to be made into elixirs. The official preparation is "aromatic elixir," which is a very pleasant preparation, and is designed simply as a vehicle for other substances. Illustrations of the methods of prescribing elixirs are appended on the following page:

℞.
Lithii citratis, ʒij;
Elix. aurantii, fʒiij.
Ft. solutio.
Sig. A tea-spoonful 4 times a day.
N. W.

℞.
Antipyrin., ʒj;
Elix. aurantii, fʒj.
Ft. solutio.
Sig. A tea-spoonful every 2 hours, as directed. B. N. W.

℞.
Potass. acet., ʒiiss:
Ext. junip. fld., fʒss;
Elix. aurantii, fʒiv;
Aquæ, q. s. ft. Oss.
Sig. A dessert-spoonful 3 times a day. P. S. T.

℞.
Quininæ sulph., gr. xvj;
Cinchonidin. sulph.,
Cinchoninæ sulph., āā. gr. viij;
Elix. aurantii, Oj.
Ft. solutio.
Sig. A tea-spoonful 3 times a day.
M. M.

℞.
Potass. brom., fʒv;
Acid. citric., gr. viij;
Elix. aurantii, q. s. ft. fʒiv.
Ft. solutio.
Sig. A tea-spoonful as required.
O. R. L.

℞.
Ext. paulliniæ fld., fʒiss;
Ext. glycyrrhizæ fld., fʒss;
Elix. aurantii, fʒvj.
Ft. mistura.
Sig. A tea-spoonful every 3 hours.
W. S. R.

Ethereal Solutions.

Collodia (Collodions).—Collodions are liquid preparations used for external application. They are made by dissolving pyroxylin or gun-cotton in a mixture of ether and alcohol, and are variously medicated, being thus made the vehicles of several important medicines. When applied to the skin the ether and alcohol evaporate, leaving a thin film, which either acts as a protection to the surface below or brings a medicinal agent in contact with the part to which it is applied. The following collodions are official: Collodion, collodion with cantharides, flexible collodion, and styptic collodion. Ordinary collodion produces a film which is slightly contractile; flexible collodion contains a trace of castor oil and Canada turpentine: these being non-volatile, the film is rendered softer and somewhat elastic. Flexible collodion is used when a covering for the epidermis is needed which will allow of some motion of the part, as, for instance, upon an abraded knuckle. Several other forms of collodions have come into use for special purposes, as carbolized collodion and iodoform collodion.

Herewith are presented some of the modes of prescribing collodions:

℞.
Collod. c. canth., f℥ss.
Sig. Apply with a camel's-hair brush, as directed.
T. N.

℞.
Tinct. iodi.,
Spt. ammoniæ,
Collodii, *āā.* f℥ij.
M.
Sig. Apply at night, as directed.
V. V.

℞.
Acid. carbolic., gtt. ij;
Collod. flexilis, f℥ss.
M.
Sig. Apply as directed.
L. A.

℞.
Iodoformi, gr. v;
Collod. flexilis, f℥ij.
Ft. solutio.
Sig. Brush upon the part, as directed.
M. K.

Oleaginous Solutions.

Linimenta (Liniments).—Liniments are preparations to be applied to the skin, usually by friction, and are generally liquid or of such consistence as to become liquefied when applied. They are largely used and are valuable preparations, most of them being beneficial not only on account of their intrinsic merits, but because the friction usually employed in their application induces more or less counter-irritation.

The following official liniments may be used by inunction: ammonia, belladonna, camphor, chloroform, soap, soft soap, and compound liniment of mustard.

Lime liniment and liniment of turpentine are used for burns, and are simply applied to the affected parts.

Liniments may be prescribed as follows:

℞.
Thymol., ℥ss;
Ol. terebinth., f℥ij;
Ol. origani, f℥iv;
Ol. gossypii, f℥v.
Ft. linimentum.
Sig. Rub into the affected parts.
A. W. L.

℞.
Tinct. aconiti,
Chloroformi,
Aq. ammoniæ, *āā.* f℥ij;
Linim. saponis, q. s. ft. f℥viij.
Ft. linimentum.
Sig. Use as directed, locally.
N. W.

℞.
Lin. aconiti,
Lin. belladonnæ, *āā.* f℥ij;
Lin. saponis, q. s. ft. f℥ij.
Ft. linimentum.
Sig. Apply as directed.
C. E. M.

℞.
Ol. tereb., f℥iij;
Ovi vitelli, j;
Ol. limon., ♏.xxx;
Acid. acetic., f℥v;
Aq. rosæ, f℥iiss.
Ft. linimentum.
Sig. Apply as directed.
A. C. B.

Oleata (Oleates).—Oleates are preparations made by dissolving alkaloids or metallic oxides in oleic acid. Some are solid and some are liquid; three, which are official, oleate of mercury, oleate of veratrine, and oleate of zinc, are semi-liquid, being solutions of the oleates in an excess of oleic acid. They have been recommended as being more readily absorbed when applied to the skin, and therefore quicker and more efficient in their action, than ordinary ointments prepared with other fatty bodies, while at the same time they are more cleanly in their application.

Some of the unofficial oleates are compounds containing oleic and stearic acids; these are usually in the form of fine powder.

The following prescriptions exhibit the use of oleates:

℞.
Zinci oleati,
Talci præparati, āā. ʒss.
Misce et fiat pulv. subtil.
Sig. Dust upon the part night and morning. U.

℞.
Oleati veratrin., fʒss.
Sig. Apply with a camel's-hair brush, as directed. M. N.

℞.
Cupri oleati, ʒi;
Petrolati, ʒiij.
Ft. unguent.
Sig. Apply with caution night and morning. R. A. S.

℞.
Hydrargyri oleati (20%), ʒss;
Lanolini, ʒiiss.
Ft. unguent.
Sig. Apply 3 times daily. V. W. R.

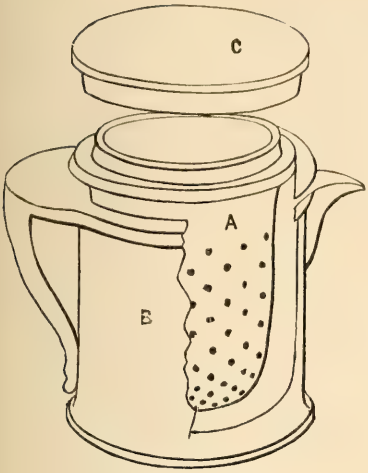
Aqueous Liquids made by Percolation or Maceration.

Infusa (Infusions).—Infusions are solutions of the soluble principles of drugs, either in cold or hot water, made without boiling. They are not permanent preparations, undergoing decomposition in a short time, and should not be prepared in larger quantities than the immediate occasion demands.

Infusions of drugs which contain either volatile principles or principles that are injured by heat should be made with cold water. Infusions can be made more quickly by the use of hot water, but in consequence of the solution of extractive and inert matters which are very slowly deposited when the infusions cool, preparations thus made are not clear, the precipitated particles being so minute that they cannot be separated by straining or filtration.

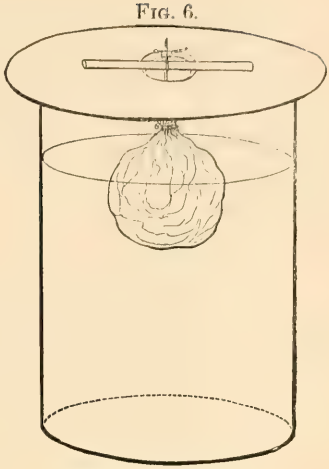
The official processes for infusions are maceration and percolation. By maceration is meant soaking a drug in a menstruum until it is softened and the soluble portion is dissolved. Fig. 5 shows Squire's infusion mug. The substance to be infused is deposited in the queensware colander A; this is placed then in the mug B; hot or cold water poured over it, the cover C put in position, and the whole allowed to stand for the required length of time. In Fig. 6 a simple method of

FIG. 5.



Squire's Infusion Mug.

FIG. 6.



Circulatory Solution.

making an infusion which obviates the necessity of straining is shown. The substance, properly comminuted, is tied in a piece of cheese-cloth or muslin, as shown, and then suspended at the top of the liquid. The liquid in contact becomes saturated, falls to the bottom, and fresh liquid takes its place, a circulatory solution being effected. In Fig. 7 an application of this principle for making hot infusions is shown. There are four official infusions, two of which are made by maceration in boiling water: these are infusion of digitalis and compound infusion of senna, both of which are directed, after maceration, to be strained. The other two are made by percolation with cold water, the infusion of cinchona without previous maceration, a small quantity of aromatic sulphuric acid being added to the water for the purpose of rendering the alkaloids more soluble; and the infusion of wild cherry, which is allowed to macerate for one hour before percolation.

FIG. 7.

Infusion Mug (home-made).

The process of digestion is frequently used in preparing infusions, and consists in macerating the infused substance in water for a length

of time at a moderately elevated temperature, below boiling heat, the solvent powers of the menstruum being thereby increased.

Another process of making infusions is frequently adopted, that of diluting fluid extracts with water. This plan, as a general rule, is a bad one, and not to be justified unless the active principles of the drug were equally soluble in alcohol and in water, which would very rarely be the case; it should never be followed when an official infusion is prescribed.

℞.

Potass. brom., ℥ss;
Inf. gent. comp., f℥viij.
Ft. solutio.

Sig. A dessert-spoonful every 4 hours. G. M.

℞.

Potass. chlor., ʒss;
Inf. rosæ comp., f℥iv.
Ft. gargarisma.

Sig. Use as directed. V. T.

℞.

Ext. pilocarpi fld., fʒj;
Inf. buchu, f℥vss.
Misce.

Sig. Two table-spoonfuls every 4 hours. A. R. L.

℞.

Tr. aconit. rad., fʒss;
Inf. digitalis, f℥iv.
Misce.

Sig. A table-spoonful every 4 hours. W. K.

Decocta (Decoctions).—Decoctions are liquid preparations made by boiling drugs with water. These, like infusions, are not permanent preparations, being decomposed even more quickly than infusions. Many substances yield their soluble portions more readily and completely to the continued action of boiling water than if the temperature is lower, and therefore, where haste is important or where the active principles of the drug are with difficulty extracted, decoction is preferable to infusion. Many drugs, however, are injured by heat, a portion of their active principles being either destroyed or rendered inert, while at the same time the decoction becomes loaded with starchy and gummy matters that have no medicinal activity. Decoctions are perhaps more used as domestic remedies than they are prescribed by physicians. While there is a general formula given in the Pharmacopœia for the preparation of decoctions, there are only two which are official: these are decoction of cetraria and compound decoction of sarsaparilla.

The official general formula is as follows:

An ordinary decoction, the strength of which is not directed by the physician nor specified by the Pharmacopœia, shall be prepared by the following formula:

Take of

The substance, coarsely comminuted,
(metric) 50 gm. (old form) 365 grains;

Water, a sufficient quantity to make 1000 c.c. 1 pint (old form).

Put the substance into a suitable vessel provided with a cover; pour

upon it 1000 c.c. (or old form 1 pint) of cold water; cover it well, and boil for fifteen minutes; then let it cool to about 40° C. (104° F.); strain the expressed liquid, and pass through the strainer enough cold water to make the product measure 1000 c.c. (or old form 1 pint).

Caution.—The strength of the decoctions of energetic or powerful substances should be specially prescribed by the physician.

The following are prescriptions for decoctions:

℞.

Hydrarg. chlor. cor., gr. j;
Potassii iodid., ʒij;
Decoct. sarsap. comp., Oj.
Ft. decoctio.
Sig. Two tablespoonfuls 3 times a day.

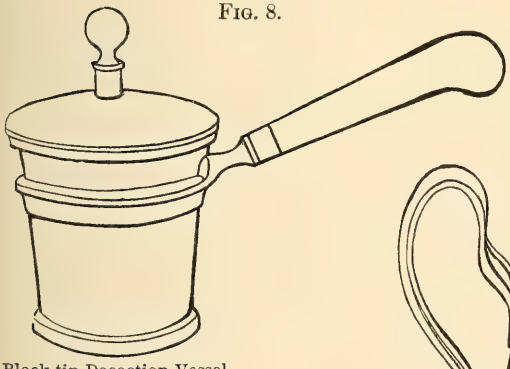
F. F. M.

℞.

Ext. aloes. aq., ʒj;
Myrrhæ,
Croci, āā. gr. xlv;
Potass. carb., ʒss;
Ext. glycyrrhiz., ʒiv;
Tinct. card. comp., fʒiv;
Aquæ, q. s. ft. fʒviij.
Ft. decoctio.
Sig. A tablespoonful at night.

V. T.

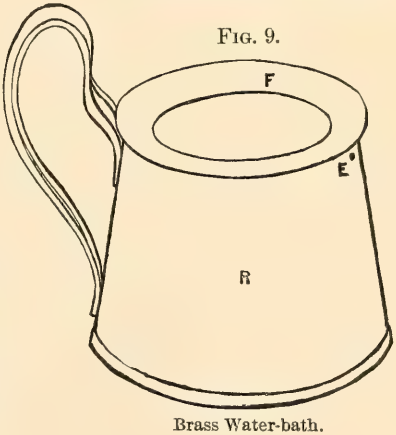
Fig. 8.



Block-tin Decoction Vessel.

Figs. 8 and 9 show apparatus for preparing decoctions. Fig. 8 represents a vessel made of solid block tin; it has a cover and a long wooden handle. The drug is placed in the vessel, covered with water, and heated; if care is necessary to prevent too much heat, the vessel is heated in the water-bath R (Fig. 9), which is kept nearly full of water.

Fig. 9.



Brass Water-bath.

Aceta (Vinegars).—The medicated vinegars of the Pharmacopœia are solutions of the active principles of drugs in vinegar or acetic acid. Vinegar is a solvent of many substances that are insoluble in water. It is a good solvent of alkaloids, which it converts into acetates, and thereby perhaps renders them more active without essentially modify-

ing their remedial action. In consequence of the variable strength of vinegar, and at the same time of its containing impurities and vegetable principles that are very liable to decomposition, the official vinegars are directed to be made with diluted acetic acid, and are thereby rendered much more uniform and stable.

There are two vinegars official—namely, those of opium and squill; the strength of each of these is 10 per cent. of the drug, and they are both directed to be made by maceration. These preparations are not very frequently prescribed, but the vinegar of squill is largely used in preparing the syrup of squill, which is a popular remedy extensively employed.

When it is undesirable to introduce alcohol into the system—which would occur if tinctures or fluid extracts were used—or when a small quantity of acid is needed, the vinegars are useful preparations. They are usually prescribed in combinations somewhat similar to those in the following formulas:

℞.		℞.	
Morph. acet.,	gr. j;	Acet. opii,	f℥j;
Acet. scillæ,	f℥ss;	Acet. lobeliæ,	f℥j;
Syr. ipecac.,	f℥j;	Syr. senegæ,	f℥ss;
Syr. tolu., q. s. ft.	f℥iv.	Syrupi, q. s. ft.	f℥iv.
M. Ft. solutio.		M. Ft. mistura.	
Sig. A tea-spoonful when the cough is troublesome.		Sig. A tea-spoonful 3 or 4 times a day.	
	V.		W.

Alcoholic Liquids made by Percolation or Maceration.

Tincturæ (Tinctures).—Tinctures, according to the Pharmacopœia, are alcoholic or hydro-alcoholic solutions of medicinal substances. Alcohol is perhaps the best solvent of the active principles of most vegetable drugs, dissolving active principles that are not soluble or are slightly soluble in water, while it does not dissolve various inert substances that are soluble in water; thus, essential oils, resins, or oleo-resins require strong alcohol as the solvent, being practically insoluble in water. On the other hand, diluted alcohol—*i. e.* alcohol diluted with an equal volume of water—is used in preparing many of the tinctures, in preference to strong alcohol, since it dissolves more of the active principles which are soluble in water, and many drugs contain principles which are most soluble in diluted alcohol; as, for example, drugs which contain tannin or extractive matter, or the natural salts of the organic alkaloids combined with essential oils or resin; in such cases alcohol diluted with water would be the most proper solvent.

Diluted alcohol contains a sufficient quantity of alcohol to preserve

preparations made with it from change or decomposition, is cheaper, and has the further advantage of giving less alcohol in the dose.

Active medicines, or those of which the dose is small, are very conveniently administered in tinctures; the amount of alcohol in them is inappreciable, but in the tinctures of the weaker medicines the amount of alcohol to be given is in many cases so great as to be objectionable, and other means of presenting the medicines is desirable; in such cases the fluid extracts are often available.

Tinctures have always been popular as medicines, seventy-two being official in the U. S. P., 1890, and of fifty-one tinctures official in the U. S. P. of 1820, forty-two are still official.

Most of the tinctures are directed to be made by percolation, the drugs, in powder, having been previously allowed to macerate for a short time; when the process is skilfully performed the result is satisfactory and leaves nothing to be desired. The following is a list of the tinctures directed to be prepared in this manner:

Tincture of aconite,
" aloes,
" aloes and myrrh,
" arnica-flowers,
" arnica-root,
" bitter orange-peel,
" sweet orange-peel,
" belladonna leaves,
" bryonia,
Compound tincture of catechu,
Tincture of chirata,
" cimicifuga,
" cinchona,
Compound tincture of cinchona,
Tincture of cinnamon,
" colchicum seed,
" saffron,
" conium,
" cubeb,
" digitalis,
" nutgall,
" calendula,
" calumba,
" Indian cannabis,
" cantharides,
" capsicum,
" cardamom,
Compound tincture of cardamom,
Tincture of quillaja,
" opium,
Deodorized tincture of opium,
Tincture of physostigma,
" pyrethrum,
" quassia,
" rhubarb,
" strophanthus,
Aromatic tincture of rhubarb,
Sweet tincture of rhubarb,
Tincture of sanguinaria,
" squill,
" serpentaria,
" gelsemium,
Compound tincture of gentian,
Tincture of hops,
" hydrastis,
" hyoscyamus,
" ignatia,
" krameria,
Compound tincture of lavender,
Tincture of lobelia,
" matico,
" stramonium seed,
" sumbul,
" valerian,
Ammoniated tincture of valerian
Tincture of vanilla,
" veratrum viride,
" ginger.

In the hands of inexperienced operators the plan of maceration with frequent agitation will be found more satisfactory. In this method,

however, there will always be more or less loss, since there will always be a portion of the liquid retained in the dregs, however thoroughly they may be expressed after maceration.

Gums and gum-resins, owing to their adhesive nature, are not easily percolated, and consequently the tinctures of these are directed to be made by maceration; and seven days is the length of time specified for most of them.

The following tinctures are thus prepared, and after maceration are separated from the dregs by filtration through paper:

Tincture of asafetida,
" benzoin,
Compound tincture of benzoin,
Tincture of guaiac,
Ammoniated tincture of guaiac,
Tincture of myrrh,
Camphorated tincture of opium,
Tincture of lactucarium.

The same length of time is not necessary for such substances as are almost wholly soluble in alcohol; thus, tincture of kino and tincture of green soap are directed to macerate only until the respective drugs are dissolved. In the case of tinctures of fresh herbs a longer maceration is necessary, and the Pharmacopœia has extended the time to fourteen days.

The following, although classed among the tinctures, are simply solutions of substances that are perfectly soluble, and therefore would more properly be called alcoholic solutions:

Tincture of nux vomica,
" ferric chloride,
" iodine,
Tincture of tolu,
" ipecac and opium,
" kino.

Tinctures are prescribed so largely, and differ so much in physical properties, that no general rules can be formulated for their proper combination. Resinous tinctures should not be directed to be mixed with aqueous solutions without providing for the suspension of the precipitated resin by the use of sufficient acacia; hydro-alcoholic tinctures and resinous tinctures should not be mixed together for the same reason. Mucilage of acacia and strong syrup are precipitated if mixed with tinctures containing strong alcohol.

The following prescriptions exhibit some of the forms in which tinctures are prescribed:

℞.
Tinct. digital., f℥ss;
Ext. ergotæ fld., f℥iiiss.
M.
Sig. A tea-spoonful thrice daily.
B.

℞.
Tinct. strophanthi, f℥j.
Sig. Five drops 3 times daily.
F.

℞.

Tinct. krameriæ,	f℥iv ;
Tinct. opii,	f℥ij ;
Mist. cretæ, q. s. ft.	f℥iij.

M.

Sig. A tea-spoonful 3 times a day.

℞.

Tinct. guaiaci,	f℥ss ;
Ext. cannabis,	gr. xvj ;
Syr. tolut.,	f℥j ;
Pulv. acaciæ,	q. s.
Aquæ, q. s. ft.	f℥ij.

M. Ft. mistura.

Sig. A tea-spoonful in water.

F. F. V.

℞.

Tinct. iodi co.,	f℥ss ;
Aq. ammon. fort.,	f℥ss.

M.

Sig. Apply externally with a camel's-hair brush. M. B. M.

℞.

Tinct. cantharidis,	f℥ij ;
Tinct. ferri chlor.,	f℥vj.

M.

Sig. Twenty drops in water through a glass tube, thrice daily.

H. C. W.

℞.

Tinct. gelsemii,	f℥j ;
Tinct. belladon.,	f℥ij.

M.

Sig. Fifteen drops at bedtime.

A. R. T.

Vina Medicata (Medicated Wines).—Medicated wines are solutions in wine of the soluble principles of medicinal substances. They contain less alcohol than tinctures, and are therefore less stimulating, while there is enough alcohol in them to render them much more permanent than infusions or decoctions. Most wines are liable to undergo decomposition, more especially when imbued with the soluble principle of vegetable drugs. White wine is the kind directed to be used in making the wines of the Pharmacopœia, and in order to make these preparations more permanent its alcoholic strength is increased by the addition of 1 part of alcohol to 7 parts of wine; this preparation is known as Vinum Album Fortius, or stronger white wine, and is required to contain not less than 20 per cent., nor more than 25 per cent., of alcohol.

In the Pharmacopœia previous to 1880 the imported wines sherry and port were official, sherry being used as the menstruum for preparing the medicated wines; but no directions were given respecting the amount of alcohol contained in it, and consequently the medicated wines as usually found were very variable in alcoholic strength, and very often had not enough alcohol to preserve them. But in 1880 the committee of revision decided not to recognize any special variety of wine, and adopted the titles "vinum album" (white wine) and "vinum rubrum" (red wine), and permitted any wine to be used, whether imported or not, provided it was sufficiently pure and had the required alcoholic strength.

There are fourteen official wines; of these, two are not medicated—viz. white wine and red wine; two are prepared by percolation—the wines of colchicum-root and ergot; two are prepared by maceration—viz. the wines of colchicum-seed and opium; and the remaining four are made by simple solution or admixture; these are bitter wine of iron, wines of antimony, ferric citrate, and ipecac.

The following illustrations show the use of medicated wines:

℞.

Morph. sulph.,	gr. j;
Vin. colchici,	f℥j;
Magnesiæ,	℥j;
Aq. menth. pip.,	f℥iv.

Misce.

Sig. A table-spoonful thrice daily.

W. T. B.

℞.

Tinct. nuc. vom.,	f℥iv;
Syr. tolut.,	f℥ij;
Vin. ferri, q. s. ft.	f℥iv.

Misce.

Sig. A tea-spoonful after meals.

B. B. N.

℞.

Syr. scillæ,	f℥j;
Syr. picis liq.,	f℥iss;
Tinct. opii,	f℥ij;
Vin. antimonii,	f℥ss.

Ft. mistura.

Sig. A tea-spoonful at night.

W. V. K.

℞.

Sod. borat.,	gr. ij;
Vin. opii,	gtt. v;
Aqua dest.,	f℥j.

Ft. collyrium.

Sig. Drop in the eye as directed.

M. L. V.

Extracta Fluida (Fluid Extracts).—This class of preparations is the largest and one of the most important, if not the most important one, in the United States Pharmacopœia. Having been made official for the first time in 1850, when seven were introduced, they have so increased in popularity and number that formulas for preparing eighty-eight are given in the U. S. P. of 1890, and for fifty-two others in the National Formulary, in addition to which there have been placed upon the market by various manufacturers an endless variety of fluid extracts of almost all the vegetable drugs that are known to medical science.

Fluid extracts are alcoholic or hydro-alcoholic solutions of the soluble principles of vegetable drugs, of such strength that 1000 grammes of drug are fully represented by 1 litre of fluid extract, or 1 gramme by a cubic centimetre (a millilitre). This is a slight change of strength from the Pharmacopœia of 1870. At that time the fluid extracts were to be made so that each minim represented one grain of the drug; but as there exists no fixed relation between minim and grain, it was thought best to adopt the metric system, in which one gramme is the exact weight of one cubic centimetre of distilled water;

to express this relation more clearly the term fluigram has been proposed. This involved a change of 5 per cent., the strength being thereby rendered 5 per cent. weaker—a change not sufficient to be appreciated in dosage.

The great advantage of fluid extracts over other liquid preparations of the same drug consists in their concentration and consequent convenience, their permanence, and in the uniform relation of their strength to the drugs from which they are prepared. They are much more concentrated than tinctures, and are thereby rendered more portable; at the same time the dose required is much smaller and contains less alcohol, which in many cases is contraindicated therapeutically. Inasmuch as they fully represent the drugs from which they are prepared by containing all their soluble principles, they are in very many cases superior to the various alkaloids and active principles, which are generally only partial representatives of the medicinal activity of these drugs.

The subject of menstrua (the liquids used to extract the soluble principles) has been carefully studied, and very many experiments have been made with the view of ascertaining the best menstruum for each individual fluid extract. Some drugs require much stronger alcohol to exhaust them than others, and with all, when an alcoholic menstruum is used, a sufficient amount is taken to exhaust the drug thoroughly, and enough alcohol is allowed to remain in the finished extract to render it permanent; this latter object is still further ensured by the addition in some cases of a small quantity of glycerin to the menstruum.

Some drugs—as, for example, triticum and castanea—are best exhausted by boiling water, and in these cases, after exhausting the drugs by percolation, the liquid is evaporated to the proper degree, and to preserve it a sufficient quantity of alcohol is added to make the finished product contain 20 per cent.

The official process for making fluid extracts is by percolation, and, as described in the Pharmacopœia, consists in subjecting a substance in powder, contained in a vessel called a percolator, to the solvent action of a menstruum in such a manner that the liquid as it passes through the powder in its descent to the recipient shall be charged with the soluble portion of it, and be free from insoluble matter. The following is given as a typical formula:

One thousand grammes of a drug reduced to the proper degree of fineness having been moistened with a specific quantity of menstruum, are carefully packed in a suitable percolator, and a sufficient quantity of menstruum added thoroughly to saturate the powder. When the liquid begins to drop from the percolator, the lower orifice is closed with a cork, and the drug is allowed to macerate for a certain time; additional menstruum is then poured on, and, the cork having been removed, perco-

lation is continued until the drug is exhausted. Ordinarily, the first 700 to 900 c.c. of liquid passing through are reserved, and the remainder, having been evaporated to the consistence of a soft extract, is dissolved in the reserved portion. A sufficient quantity of menstruum is then added to make the whole measure 1000 c.c.

The value of the resulting fluid extract will of course depend upon the manner in which the prescribed directions are followed; and, with a proper selection of the drug, if the process of percolation is carefully and skilfully conducted, the results cannot fail to be satisfactory.

℞.
Ext. uvæ ursi fld., f℥j;
Ext. tritici fld., f℥ij.
Misce.
Sig. A tea-spoonful in water 3 times a day. O. K.

℞.
Potass. acet., ʒij;
Ext. buchu. fld., f℥ij.
Ft. solutio.
Sig. A tea-spoonful 4 times a day. L. L.

℞.
Ext. verat. virid. fld., f℥ss.
Sig. Two drops in water, as directed. B. K. S.

℞.
Ext. erythroxyli fld., f℥j;
Vin. xerici,
Syr. tolut., āā. f℥iij.
Misce.
Sig. A tea-spoonful 4 times a day. W. B. K.

℞.
Ext. lactucæ fld., fʒvj;
Syr. scillæ, f℥iss;
Tinct. opii, f℥ss;
Syr. pruni virg., q. s. ft. f℥iv.
Misce.
Sig. A tea-spoonful when the cough is troublesome. L. D.

℞.
Ext. rhei aromat. fld., f℥j;
Ext. aromat. fld., fʒiv;
Syrupi, f℥vij.
Misce.
Sig. A tea-spoonful 3 times a day. W. N.

℞.
Ext. aconit. fld., fʒvj;
Lin. saponis, fʒiv.
Ft. liniment.
Sig. Apply as directed. W. N. T.

℞.
Ext. digital. fld., fʒij;
Ext. aconit. rad. fld., fʒvj.
Misce.
Sig. Two drops in water 3 times a day. V. W. M.

℞.
Ext. grindeliæ fld., fʒiv;
Aquæ font., f℥vss.
Misce.
Sig. Apply constantly to the inflamed surface. W. R.

℞.
Ext. pilocarpi fld., fʒij;
Liq. potass. cit., f℥iij.
Misce.
Sig. A tea-spoonful every two hours. V. M.

℞.
Potass. chlor., ʒj;
Ext. rhois glab. fld., fʒss;
Inf. rosæ comp., q. s. ft. fʒiv.
Ft. gargarisma.
Sig. Use as a gargle, as directed.
M. B.

℞.
Acid. nitrohydrochlor. dil., fʒiij;
Ext. chiratæ fld., fʒj;
Ext. tarax. fld., q. s. ft. fʒiv.
Misce.
Sig. A tea-spoonful before meals.
G. O. M.

Ethereal Liquids made by Percolation or Maceration.

Oleoresinæ (Oleoresins).—Oleoresins are liquid preparations made by extracting from certain vegetable substances the natural oils and resins contained therein by means of percolation with ether. They are much more concentrated preparations than fluid extracts, and do not bear any fixed and definite relation to the drugs from which they are prepared, as do the fluid extracts; moreover, they do not contain exactly the same constituents as fluid extracts of the same drugs, since alcohol and ether possess different solvent powers, many substances soluble in one being insoluble in the other. They should be entirely free from the odor of ether or benzin, this latter substance being sometimes substituted for ether in making these preparations—a proceeding which is entirely unjustifiable.

Owing to the powerful and disagreeable taste and odor of the oleoresins, they are usually given enclosed in capsules of gelatin, in pills, or emulsified, so as to obtund the taste, as the prescriptions given below indicate.

The official oleo-resins are those of aspidium, capsicum, cubeb, ginger, lupulin, and pepper.

℞.
Oleoresinæ cubebæ, ♏xij.
Ft. capsulæ No. iv.
Sig. One, twice a day.
X.

℞.
Ol. terebinth.,
Oleores. aspidii, āā. fʒj;
Sodii chlorid., gr.xv;
Pulv. acaciæ, q.s.
Aquæ, q. s. ft. fʒij.
M. ft.
Sig. Two tea-spoonfuls taken fasting.
W.

℞.
Oleores. capsici, ♏x;
Linim. saponis, fʒiv.
Sig. Apply at night, as directed.
Q. E. D.

℞.
Copaibæ,
Oleores. cubebæ, āā. fʒij.
M. Ft. capsulæ molles No. xx.
Sig. One, 3 times a day.
V. R.

℞.
Morph. acet.,
Oleores. capsici, āā. gr. j ;
Pulv. camphoræ,
Ext. hyoscyami, āā. gr. xx.
Ft. massa et div. in pil. No. xx.
Sig. One, at night. W. R. T.

Solids.

Preparations made by Percolation or Maceration.

Extracta (Extracts).—Extracts of the Pharmacopœia are solid or semisolid preparations, prepared by extracting the soluble principles of drugs and evaporating the solutions to a proper consistence ; these solutions are prepared either by expressing the juice from the fresh plant or by extracting the soluble principles of the dried drug by means of a solvent. Most of the extracts are directed to be prepared by percolation, and the solutions thus obtained evaporated to the proper consistence by means of a water-bath. They are valuable preparations, affording the means of administering various medicines in pilular form, and when properly made preserving for a long time their virtues unimpaired. They are usually prepared either of such soft consistence as to be readily made into pills, or are reduced to dryness, so that they can be powdered. Thus, aqueous extract of aloes is a dry extract, and extract of colocynth is directed to be in powder. Some of the soft extracts are evaporated until brought to pilular consistence, such as extract of gentian or extract of rhubarb. Many of the powdered extracts found in the market, although purporting to be of full official strength, are very deficient, being either made of inferior drugs, improperly made, or damaged by heat in the process of drying.

The following is a list of official extracts, in addition to those named above: extracts of aconite, arnica-root, belladonna leaves, Indian cannabis, cimicifuga, cinchona, colchicum-root, digitalis, ergot, euonymus, glycyrrhiza, hæmatoxylon, iris, hyoscyamus, jalap, juglans, krameria, leptandra, nux vomica, opium, physostigma, podophyllum, quassia, stramonium-seed, taraxacum, uva ursi, the alcoholic extracts of conium and digitalis, the compound extract of colocynth, and pure extract of glycyrrhiza.

Formulæ illustrating the methods of prescribing extracts are appended :

℞.
Hydrarg. chlor. mit., gr. xij;
Pulv. ext. coloc. co., gr. xxiv;
Ext. hyoscyam., gr. xviij.
Ft. massa et div. in pil. No. xij.
Sig. One, at night.

℞.
Ferri redact., gr. xx;
Ext. nuc. vom., gr. iv;
Ext. quassiæ, gr. xvj;
Pulv. sapon., gr. viij.
Ft. massa et div. in pil. No. xij.
Sig. One, after meals. V. Q.

℞.
Ext. belladon., gr. vj;
Ext. cannab. Ind., gr. viij;
Ext. ergotæ, gr. l.
Ft. massa et div. in pil. No. xvj.
Sig. One or two during the day as directed. R.

℞.
Ext. aloes, gr. vij;
Ol. carui, gtt. j;
Ext. gentianæ, gr. viij.
Ft. massa et div. in pil. No. vj.
Sig. Two, at night. V. W.

Abstracta (Abstracts).—Abstracts were introduced into the Pharmacopœia of 1880, and were designed with the view of taking the place of various powdered extracts that were found in the market, and which, as prepared by the different manufacturers, varied very greatly in composition and strength. These differences arose from different makers using different menstrua to exhaust the drugs, and in many cases were caused by using too great heat in their preparation during the process of drying.

Another objection to powdered extracts lies in the fact that many of them are slightly hygroscopic, and in consequence after being kept a short time they run together and become hard and tough masses which are very unmanageable.

Abstracts possess certain advantages over both extracts and fluid extracts: they are made of definite strength, 2 parts of drug being represented by 1 part of abstract, being double the strength of fluid extracts. In preparing an abstract the drug is thoroughly exhausted of soluble principles by alcohol; the tincture thus obtained, after being mixed with a portion of sugar of milk, is evaporated spontaneously at a low temperature until it becomes dry; it is then mixed with a sufficient quantity of sugar of milk to make the product weigh one-half the weight of the drug used, and reduced to a uniform fine powder. The drug is thus presented in a soluble condition, and, not being subjected to a temperature at any time exceeding 158° F., it is not injured by heat. They are permanent preparations, are very portable, and will retain their pulverulent condition indefinitely if proper precautions are taken to protect them from moist air; they should be kept in a cool place. They contain no alcohol, and can be conveniently administered

in capsules. Their definite relation to the drugs from which they are prepared is of importance and value to the physician in fixing the dose, which is just one-half that of the drug itself or of its fluid extract, while the dose of solid extracts bears no such relation to the drug and varies with each preparation.

The following abstracts were official: viz. abstracts of aconite, belladonna, conium, digitalis, hyoscyamus, ignatia, jalap, nux vomica, podophyllum, senega, and valerian.

Illustrations are appended showing the manner of prescribing abstracts. They may be administered in powders, cachets, pills, capsules, or in solution or mixtures:

℞.
Abstract. aconiti,
Pulv. sacch. lact., *āā.* gr. vj.
M. Ft. chart. No. xij.
Sig. One every 3 hours.
M.

℞. For Willie ——.
Abstract. jalapæ, gr. xv;
Hydrarg. chlor. mit.,
Pulv. aromat., *āā.* gr. v;
Pulv. sacch. lact., gr. xxx.
Fiant chart. No. xv.
Sig. One every fourth hour.
X.

℞.
Abs. belladonnæ,
Res. podophylli, *āā.* gr. vj;
Pulv. capsici, gr. xij.
M. Fiant pil. No. xxiv.
Sig. One pill at night.
H.

℞.
Abstract. nucis vom., gr. xij;
Zinci phosphid., gr. j.
Fiant capsulæ No. xij.
Sig. One, 3 times a day.
Z.

Resinæ (Resins).—The resins of the Pharmacopœia are solid preparations, consisting principally of the resinous principles either of natural oleoresins obtained as residues after distilling off their volatile oils, or of vegetable substances prepared by precipitating with water their alcoholic tinctures.

They differ from alcoholic extracts in containing only those principles which are soluble in alcohol, but insoluble in water, while alcoholic extracts contain all the principles that are soluble in alcohol.

There are five resins official: resin, the residue obtained by distilling off the volatile oil from turpentine; resin of copaiba, the residue after distilling off the volatile oil from copaiba; and the resins of jalap, podophyllum, and scammony, made by percolating the respective drugs with alcohol and precipitating the resin by the addition of water.

Resin of podophyllum is much the most important of this group of preparations: the official resins, with the exception of resin of copaiba, are hard solids, or, as usually found in pharmacy, reduced to fine

powder. Resins are nearly always prescribed in combination with other ingredients; as, for example. in the following prescriptions:

℞.

Res. podophyll.,	gr. iij;
Pulv. capsici,	gr. vj;
Ext. belladon.,	gr. ss;
Pulv. sacch. lact.,	gr. xij.

M. Ft. pil. No. xij.
Sig. One at night. N. S.

℞.

Res. scammon.,	gr. xij;
Pulv. aloes,	gr. xv;
Ext. colocynth.,	gr. iij;
Potass. sulph.,	gr. ij;
Ol. caryoph.,	gtt. j.

M. Ft. pil. No. xij.
Sig. One or two as directed. V. T.

Extemporaneous Preparations.

Pulveres (Powders).—Powders form a convenient method of administering many medicines, such as are not deliquescent or are not particularly offensive to the taste, and of which the doses are small.

The powders of the Pharmacopœia are all compound; that is, each one consists of two or more substances mixed together. Although volatile or deliquescent substances are not suitable for powders, it sometimes becomes necessary to prescribe them in this form; in such cases the powders should be dispensed wrapped in papers coated with wax or paraffin to protect them from the air, and if required to be kept for any length of time they should be preserved in closely-stopped bottles.

The following powders are official: viz. antimonial, aromatic, compound chalk, and compound effervescing powders, powder of ipecac and opium, and compound powders of glycyrrhiza, jalap, morphine, and rhubarb.

Powders are well suited for administration to infants and children if the ingredients are not repulsive or disagreeable to the taste. In prescriptions in which it is the intention to divide the powders into convenient doses and dispense them folded in small papers, they are distinguished by the name "chartulæ."

The following are given as illustrations of the methods of prescribing powders:

℞.

Bismuthi subnit.,	gr. xij;
Pepsini,	gr. vj;
Pulv. sacch. lact.,	gr. xij.

M. Ft. pulv. et div. in chart. No. xij.
Sig. One every 3 hours. V. N.

℞.

Hydrarg. chlor. mit.,	gr. iij;
Pulv. sacch. alb.,	gr. xij.

M. Ft. pulv. et div. in chart. No. xij.
Sig. One, 3 times a day. M.

℞. For Elsie ——.

Quinin. sulph., gr. vj;
Sod. bicarb., gr. j;
Pulv. ext. glycyrrh.,
Pulv. sacch. alb., āā. gr. vj.
M. Ft. pulv. et div. in chart. No. xij.

Sig. One powder in a half-teaspoonful of syrup.

E. A. S. Y.

℞.

Abstract. bellad., gr. iij;
Pulv. opii, gr. vj;
Pulv. aromat., gr. iv;
Pulv. sacch. lact., gr. xij.
M. Ft. pulv. et div. in chart. No. xij.

Sig. One powder every 4 hours, as directed.

L.

Triturationes (Triturations).—This title has been adopted by the Pharmacopœia to signify powders prepared by triturating 1 part of a medicinal substance with 9 parts of sugar of milk. While a general formula for their preparation is given, there is only one trituration official, that of elaterin, and it furnishes a convenient form for administering this powerful remedy; but it is doubtful whether such an official preparation is desirable, and perhaps it would be better to leave such mixtures to extemporaneous prescription.

In prescription it would be desirable to combine the trituration with an aromatic to prevent griping.

℞.

Trit. elaterini, gr. vj;
Pulv. aromat.,
Pulv. sacch. alb., āā. gr. xij.
Ft. pulv. et. div. in chart. No. xij.

Sig. One, as directed.

V. W.

℞.

Trit. elaterini, gr. vj;
Oleores. capsici, gtt. j;
Pulv. micæ panis, gr. xij.
Ft. pulv. et div. in cachet No. xij.

Sig. One, as directed.

L. N.

Wafers or Cachets (Cachet de Pain).—Wafers are prepared by pouring a thick, smooth mixture of flour and water between greased hot polished plates or cylinders, so adjusted that a thin sheet or wafer is produced; by the rapid evaporation of the water the wafer becomes spongy in its character. When dry it is hard and brittle, but when moistened it becomes soft, tough, and slippery, and is well adapted for taking medicines in the form of powder. A powder may be conveniently administered by placing it upon a piece of moistened wafer laid upon a table-spoon, and folding the corners so as to cover it completely, when with the aid of a little water it can very readily be swallowed.

The cachet, or as sometimes called "cachet de pain," consists of two concave pieces of wafer, varying in size from $\frac{3}{4}$ inch to $1\frac{1}{8}$ inches in diameter, round or oblong in shape, in one of which the powder to

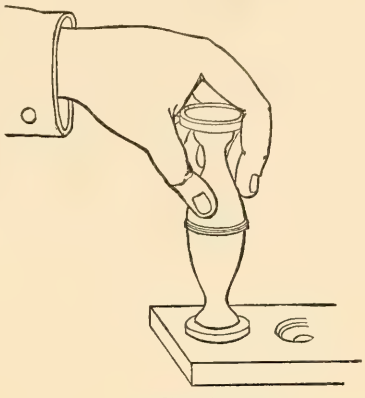
be administered is placed, and the other, having previously been moistened, is then laid over the powder and the two margins are pressed together, when they adhere and completely enclose the powder.

The apparatus used for preparing "cachets" is shown in Figs. 10, 11, and 12. In Fig. 10 the lower cachet, filled with powder, is seen,

FIG. 10.

Cachet-wetter and Funnel.

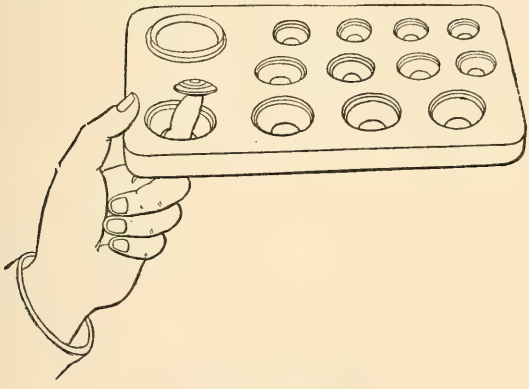
FIG. 11.



Sealing the Cachet.

above it the funnel used for the powder, and above the funnel the sealed cachet ready for use. In Fig. 11 is shown the method of sealing the cachet by pressing the upper cachet with its moistened edge upon the

FIG. 12.



Limousin's Cachet-board.

lower cachet; adhesion takes place, and the sealed cachet is pushed out of its bed in the board, as seen in Fig. 12.

Upon being floated upon a table-spoonful of water or dipped for a few seconds in water the cachet becomes soft and slippery, and, like the wet wafer, can easily be swallowed with a draught of water, the wafer when wet passing into the œsophagus imperceptibly. The advantage

of the cachet over the wafer is that no more of the enveloping material than is necessary to cover the medicine is used, and the dose can therefore be more readily swallowed, because its bulk has been reduced to the minimum.

Cachets furnish a most excellent means of administering nauseous or bitter powders, and when patients have once acquired the knack of swallowing them easily, they become very much pleased with this mode of taking medicine. Care must always be taken to explain in detail to the patient (in case the latter should not be familiar with cachets) their mode of administration, or ludicrous *faux pas* are likely to occur, such as masticating the dry cachet, or, as one patient observed to her physician on the next visit that he paid her, that she wished he would tell the apothecary not to be so particular next time to seal the medicine up "so tight in the papers," as it took a whole hour of her time to cut each one open with a pair of scissors to get the medicine out. She was very much surprised when her adviser told her that this was one of those cases in which the "papers" so called must be swallowed along with the powder.

"Cachets" may be prescribed in the following manner:

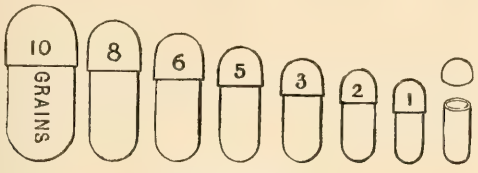
℞.
Quinin. sulph., gr. xxiv;
Ferri redacti, gr. xlviij;
Ft. pulv. et div. in "cachet" No. xxiv.
Sig. One, 3 times a day.
L. M.

℞.
Ol. croton. tig., gtt. iij;
Pulv. micæ panis (siccæ), q. s.
Ft. pulv. et div. in "cachet" No. xij.
Sig. Take two, as directed.
R.

Capsulæ (Capsules).—Capsules made of gelatin furnish a convenient method for administering nauseous or disagreeable medicines. Several kinds are in use—*hard* and *soft* capsules, which contain liquids, and *empty* capsules (cylindrical), for holding solids. Pearls are globular in shape, and differ from capsules in being *completely* filled with liquid; they thus have the advantage of being smaller in size. Ordinarily, capsules are ovoid in shape, and are prepared from a dense, hot solution of gelatin by dipping a greased bone or ivory mould into the solution, allowing the film to remain long enough to be sufficiently dry to handle, when it is dexterously pulled off; the empty capsule is then held upright and filled with the liquid medicine, and sealed by dropping some hot gelatin solution on the opening. A small air-space is left inside the capsule by this method of filling. The capsule upon drying becomes hard, and is impervious to the various medicines that can be administered in this form. The addition of glycerin to the solution of gelatin renders the capsule permanently soft. Empty

capsules are cylindrical in shape, with rounded ends, and are made in two pieces, one of which is of slightly larger diameter and fits closely over the other. The medicinal ingredient in the form of powder or pill mass is placed in the smaller cylinder, and the shorter cylinder is pressed down over it like a cap. When a liquid is used, if the edge of the lower cylinder is slightly moistened with water, it may be made

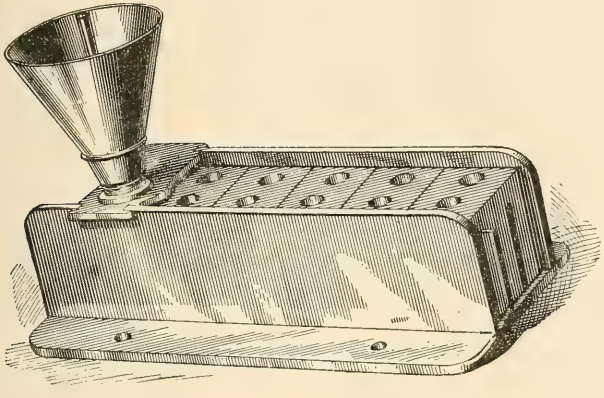
Fig. 13.



Empty Capsules.

to adhere closely to the upper piece and form a perfect joint, thus preventing leakage. Empty capsules are shown in Fig. 13, arranged

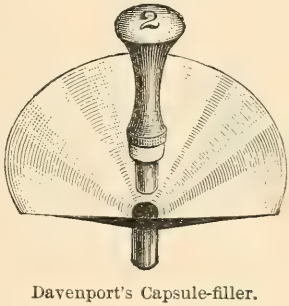
Fig. 14.



Acme Capsule-filler.

according to their respective sizes. Owing to their extended employment, they are now manufactured on an enormous scale. For filling empty capsules several machines have been invented. The "Acme" (Fig. 14) is very ingenious and simple. A block of wood holding twelve capsules is pushed into a nickel-plated metal frame which bears an inclined plane set on edge. The empty capsules having been placed in the holes, the first capsule is run under the funnel and filled; then the block is pushed to the right and No. 2 is filled, and so on until the six on the side are filled. As they are

Fig. 15.



Davenport's Capsule-filler.

pushed along they are raised out of their beds by the inclined plane, when they may be easily capped. Davenport's capsule-filler (Fig. 15) is very simple, and when small quantities are needed it answers very well. The mouth of the funnel is inserted into the capsule, and the powder, having been introduced into the funnel, is "rammed" into the capsule with the plunger. The cap is then put on, and all is complete.

The following prescriptions illustrate methods of directing medicines to be dispensed in capsules:

℞.
Ol. picis liq., ʒj.
In capsulis div. No. xij.
Sig. One, 3 times a day.
W. B.

℞.
Quinin. sulph., gr. xxiv;
Ext. nucis vomicæ, gr. xij;
Acid. arsenios, gr. j.
Ft. capsul. No. xxiv.
Sig. One, twice a day.
V. R.

℞.
Antifebrin., ʒij.
In capsulis div. No. xxx.
Sig. One or two capsules every half-hour.
D. B.

Tabellæ (Tablet-triturates).—Tablet-triturates are small disk-shaped bodies prepared by moistening medicated powders with a highly volatile liquid, then moulding the moistened powder, ejecting the tablet, and allowing the liquid to evaporate, when the tablets retain their shape. The basis of tablet-triturates is mostly finely-powdered sugar. They were first suggested by Dr. Robert M. Fuller in 1878, and are now largely employed. They possess advantages over any other method of administering solid substances, such as powders, pills, or capsules. They are much more readily and conveniently taken, and possess all the solubility of powders, which perhaps are the most inconvenient and disagreeable form of administering medicines. Capsules are more convenient than powders, but have the disadvantage of being less soluble, while pills are sometimes so insoluble as to pass through the alimentary canal without disintegration. Well-made tablet-triturates will disintegrate immediately.

The apparatus for making these tablets consists of two plates of metal, hard rubber, or other suitable material, one of them being perforated with holes having the size of the required tablets, the other having pegs upon it so situated that (when in position) these shall exactly fit into the holes in the perforated plate. The pegs must be longer than the thickness of the perforated plate, and at each end of the plate is a longer and larger peg, which, fitting into a corresponding

hole in the perforated plate, serves as a guide and secures the proper position of the plates when used.

In making tablets the medicated powder is made into a paste by moistening it with alcohol or other suitable liquid, and pressed with a spatula into the holes of the perforated plate (Fig. 16) which has previously been laid upon a pill-tile or glass plate. When the holes are

Fig. 16.

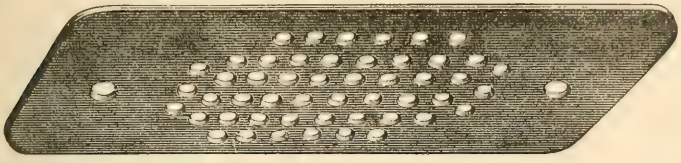
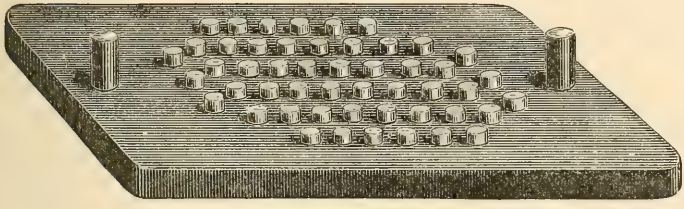


Fig. 17.



Tablet Machine.

filled, the excess of paste is cleaned off and the plate is placed over the one having the pegs (Fig. 17), and so adjusted that the larger pegs shall enter the corresponding holes in the perforated plate, which latter plate is then pressed gently down until the plates are brought into contact, and each of the smaller pegs, pushing out the paste from its corresponding hole, will have a tablet resting upon it. The plate is then set aside until the liquid has evaporated and the tablets are sufficiently dried to be removed; this requires but two or three minutes, when, after being thoroughly dried, they are ready for use. Tablets for hypodermic applications may be conveniently prepared by this process, care being taken that the ingredients are thoroughly mixed and that the quantities in each tablet are accurately proportioned.

Tablets are made by this process from powdered sugar of milk, powdered sugar, and a small quantity of acacia, without medication; these have been called blank tablets. They are used by adding the proper amount of medicated material in solution, such as an alcoholic fluid extract, and allowing the liquid to evaporate. When dried they are called tablet-saturates.

Following are given prescriptions for tablet-triturates and tablet-saturates:

℞.
Hyoscyaminæ pur., gr. $\frac{1}{60}$.
Ft. tabella trituratio.
Mitte tales xx.
Sig. One at night. W. W.

℞.
Acid. arseniosi, gr. $\frac{1}{100}$.
Ft. tabella trituratio.
Mitte tales xl.
Sig. Two, 3 times a day. N. L.

℞.
Ext. aconit. fld., ♏j.
Ft. tabella saturatio.
Mitte tales x.
Sig. Take one, every 4 hours.
A. K.

℞.
Ex. digital. fld., ♏j.
Ft. tabella saturatio.
Mitte tales xij.
Sig. Take two, every 3 hours.
W. C.

Trochisci (Troches).—Troches or lozenges are small, solid masses, generally of cylindrical or flattened shape; they are intended to be dissolved in the mouth slowly and gradually, and furnish a pleasant and convenient means of administering many remedies. Only such medicines as are used in small doses, and which have no particularly disagreeable taste, can be appropriately given in this form. Lozenges are made by beating the basis containing the medicinal agent, which is usually finely-powdered white sugar, known technically as "lozenge sugar," with sufficient mucilage of tragacanth to form a soft mass. This is rolled out on a board with a rolling-pin into a flat, smooth cake, and when of the proper thickness it is cut with a lozenge-punch or cutter. (See Figs. 18 and 19.) There are fifteen official formulas for troches, as follows: troches of sodium bicarbonate, catechu, chalk, potassium chlorate, ammonium chloride, cubeb, ginger, glycyrrhiza and opium, ipecac, iron, krameria, morphine and ipecac, peppermint, santonin, and tannic acid. Morell Mackenzie has introduced many formulæ for lozenges for throat affections which have for their basis currant-fruit paste; these have been largely used. Physicians may usually have lozenges made for them extemporaneously if the pharmacist is given an hour or two for their preparation; they require a short time to dry properly.

Fig. 18.

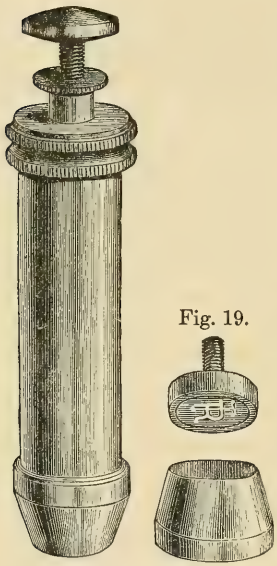


Fig. 19.

Lozenge-cutter, with Die.

Bacilli are cylindrical lozenges made by cutting the lozenge mass, rolled into a soft cylinder, on a pill-machine; the well-known Wistar's and liquorice lozenges of the manufacturers closely resemble bacilli.

The following are formulas for troches:

℞.

Res. guaiaci,	gr. lxx;
Pulv. tragacanth.,	gr. vij;
Pulv. sacch. alb.,	gr. xxx;
Gelationis ribis rub.,	q. s.

Fiant troch. No. xxxv.

Sig. One lozenge every 2 hours.

V. K.

℞.

Bismuth. subnit.,	ʒij;
Cretæ præparat.,	ʒiv;
Ol. caryoph.,	gtt. j;
Ol. cinnam. zeylan.,	gtt. j;
Pulv. sacch. alb.,	
Muc. tragacanth.,	āā. q. s.

Fiant troch. No. xl.

Sig. One lozenge, 4 times a day.

R. T.

Confectiones (Confections).—Confections are soft solids made by incorporating medicinal substances with saccharine matter, with the object of furnishing an agreeable and convenient mode of administration. Only two confections are official: confection of rose and confection of senna. Confection of rose is almost exclusively used as a vehicle for other medicines, but is also used as an excipient in making pills, to give proper consistence to the mass. Confection of senna is an agreeable and efficient laxative. Both of these confections are elegant preparations when properly made, and keep well when carefully secured.

℞.

Sulphur. sub.,	ʒj;
Conf. sennæ,	ʒiij.

M.

Sig. A tea-spoonful at night.

V. N.

℞.

Pulv. antimonial.,	gr. ix;
Pulv. res. guaiac.,	gr. xij;
Pulv. aloes. pur.,	gr. ix;
Pulv. myrrh.,	gr. vj.
Conf. rosæ,	q. s.

Ft. massa et div. in pil. No. xij.

Sig. One, 3 times a day.

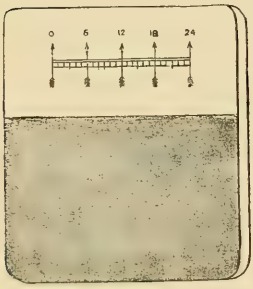
K. K.

Pilulæ (Pills).—Pills are globular or spherical solid bodies of such size that they may be conveniently swallowed; their weight varies from a grain or less to five or six grains when made of ordinary vegetable drugs, and to eight or ten grains when made of heavy mineral substances. The method of administration of medicines in pilular form is a very popular one, pills being cheap, compact, portable, convenient, and by the great majority of persons easily taken. Such medicines as are nauseous or disagreeable to the taste, and of which the dose is small, are conveniently given in this form. Pill-masses, while being sufficiently soft and plastic to be made into pill form, must be hard enough to retain their shape when thus made. Liquids or soft substances can be made into pilular form by the addition of dry inert powders, while hard substances, such as gum-resins, extracts, etc., require the addition

of a small quantity of water or of alcohol, and powders or substances which are wanting in adhesive qualities can be rendered sufficiently adhesive by the addition of mucilage, glycerin, glucose, syrup, or other viscid or tenacious liquid. A judicious selection of excipients to give the proper consistence to articles used in making pills requires good judgment, a practical knowledge of the physical properties and peculiarities of the various substances prescribed, and practical experience. One of the best excipients for general use consists of a mucilage made by gently heating a mixture of 1 part of tragacanth and 8 parts of glycerin until a uniform jelly is produced.

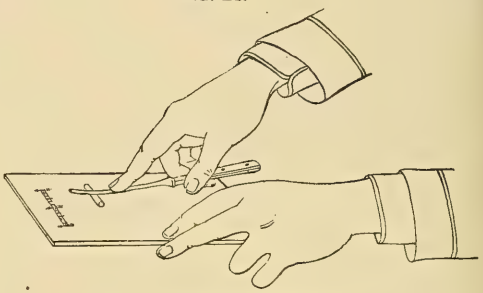
When the pill-mass has been properly made, it is rolled into a cylinder upon the pill-tile (Fig. 20), the best form of tile being that shown in Fig. 21, which is made of plate-glass, having the greater

FIG. 20.



Pill-tile.

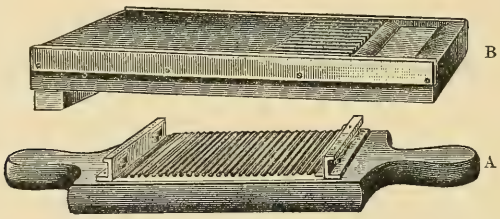
FIG. 21.



Rolling a Pill-cylinder.

portion roughened, so as to prevent the slipping of the cylinder during rolling. When pills are to be made in larger quantities, it will be found more satisfactory to use a pill-machine. This consists of two walnut boards, A, B, as shown in Fig. 22 and Fig. 23. These have

FIGS. 22, 23.



Pill-machine.

plates made of brass, with grooves in them. The pill-cylinder is laid across the grooves in B, and when A is pressed down upon it the pill-cylinder will be cut into pieces, which may then be rolled into pills.

With the view of covering their taste, as well as of rendering them more sightly, pills are covered with various substances, such as sugar,

gelatin, tolu, gold-leaf, silver-leaf, etc. The coating with sugar is usually done by machinery, and pills thus coated are made in immense quantities. Processes suitable for the retail pharmacist for coating pills with sugar on the small scale are not satisfactory, while coating with gelatin, tolu, and gold- or silver-leaf can be readily and quickly performed.

The advantages of coated pills are: they are more sightly; their disagreeable taste is concealed; they are protected from the air, and therefore keep better, being less liable to undergo change; and they retain their shape better. On the other hand, they have the disadvantage of being slower in their action in consequence of being less soluble, and sometimes their activity is greatly impaired by the use of too much heat in drying the pills preparatory to the process of coating.

Compressed pills are now very largely used; they are made by compressing dry powders into moulds by suitable machines, the force applied being sufficient to make them cohere. The advantages of this form of pill are, that, having no foreign substances or excipients mixed with the medicines employed, they are more easily and quickly dissolved in the stomach, they are handsome in appearance, and usually are more easily swallowed than ordinary pills.

Machines for making compressed pills are manufactured to be operated either by hand or steam-power, and are so arranged that pills of any size, from official troches or lozenges to hypodermic tablets, can be made very rapidly.

The following prescriptions illustrate various combinations used in prescribing pills:

℞.

Aloe purif.,	gr. xij;
Mass. hydrarg.,	gr. vj;
Res. podoph.,	gr. iss.

M. Ft. pil. No. vj.

Sig. One or two at night.

E. V. W.

℞.

Ferri sulph.,	gr. xxiv;
Potass. carb.,	gr. xvj;
Pulv. sacch. alb.,	gr. vj;
Glyc. tragacanth.,	q. s.

Ft. pil. No. xij.

Sig. One, 3 times a day. W. M.

℞

Pulv. opii,	
Ammon. carb.,	āā. gr. x;
Pulv. camphoræ,	gr. xx.

M. Ft. pil. compressæ No. x.

Sig. One at night.

M. A.

℞.

Morph. sulph.,	gr. iij;
Ext. colch. acet.,	gr. xx;
Res. podoph.,	gr. ij.

Ft. massa et div. in pil. No. xij, et cum saccharo tege.

Sig. One at night. L. W.

℞.

Aloini,	gr. vj;
Strychninæ,	gr. ss;
Ext. belladon.,	gr. iv.

Ft. massa et div. in pil. No. xxx.

Sig. One, twice a day.

C. L. B.

℞.

Ferri valer.,	gr. iij;
Zinci valer.,	gr. xxiv;
Ext. sumbul.,	gr. vj.

Ft. massa et div. in pil. No. xij, et fol. argenteo involve.

Sig. One, 3 times a day.

L. E. T.

Cerata (Cerates).—Cerates are unctuous preparations consisting of wax, mixed with oils, fatty substances, or resins, and of such consistence that at ordinary temperatures they can be readily spread upon linen or muslin, and yet so firm that they will not melt or run when applied to the skin. In this respect they differ from ointments, which are appropriately used for inunction, and become liquefied by the heat of the body when thus applied. The lard, oils, or other fatty substances from which they are prepared should be entirely free from rancidity, and as a general rule the temperature used in making them should not be higher nor continued for a longer time than is necessary to mix the ingredients thoroughly, any decomposition by heat, which would tend to render them irritating, being thereby avoided; and when prepared they should be kept as much secluded from exposure to air as possible. When, however, the virtues of some ingredient are best extracted by heat, or when an excess of liquid is to be evaporated —as, for example, in making cantharides cerate or savine cerate—a greater and more continued heat is required. Cerates prepared with white wax become rancid sooner and more readily than those prepared with yellow wax, and the cerate known as simple cerate would probably be a better preparation if made with yellow wax; but white simple cerate has been popularly known for so long a time that a colored preparation to take its place would not be received with favor.

℞.

Extracti stramonii,	ʒss;
Cerati,	℥j.

Misce secundum artem.

In compounding a prescription like the foregoing, in which an extract is directed to be mixed with a cerate, the extract should first be rubbed in a warm mortar with a little water or alcohol until reduced to a uniform, soft consistence, and then mixed with a small quantity of the cerate until thoroughly incorporated, after which the remainder of the cerate should be gradually added and the whole rubbed together until a uniform mixture is produced.

Prescriptions are frequently written directing liquids to be mixed

with cerates where the amount of liquid is excessive or greater than can be retained by the cerates; in such cases, after the cerates are saturated, the remainder is usually thrown away. Cerates, being of harder consistence than ointments, will not retain as much fluid, but the amount taken up may be increased by the addition of a small quantity of lard or oil if the softer consistence thus produced is not objectionable.

The following cerates are official: viz. cerate, camphor cerate, cantharides, resin, spermaceti, and lead subacetate.

Cerates may be prescribed as follows:

℞.

Cerat. cantharid., q. s.
Spread a blister upon adhesive plaster 3 × 7 in.
W. V.

℞.

Liq. plumbi subacet., fʒj;
Cerat. camphoræ, ʒiv.
Misce sec. art.
Sig. Apply to the part night and morning. N. T.

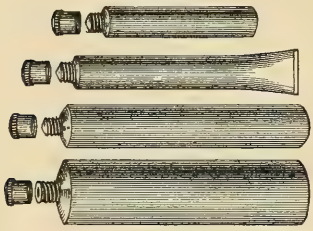
Unguenta (Ointments).—Ointments are unctuous preparations made from oils, lard, petrolatum, or other fatty substances, and of such consistence that when applied to the skin they become liquefied by the heat of the body, thus differing in consistence from cerates. In preparing and preserving ointments the same precautions which were given respecting cerates in regard to heat, rancidity, and exposure to air should be observed. Ointments are prepared either by melting the ingredients together by heat or by incorporating the medicating substance, which is generally insoluble in the fatty matter, by trituration. The mixture may be made with a mortar and pestle, or, if the substance is in fine powder, it may be mixed with the lard or other fat upon an ointment slab by the aid of a spatula; in either case care must be taken to have the ingredients thoroughly mixed and the ointment smooth and uniform. The single exception to these methods is the ointment of nitrate of mercury, in which lard oil and nitrate of mercury are heated together, when a chemical reaction takes place, resulting in the change of the olein of the oil into elaidin, with which the nitrate of mercury is subsequently mixed. In making or dispensing this ointment, as well as those containing tannic or other free acids, an iron spatula should not be used.

The following official ointments are made by fusion: ointment, diachylon, and tar ointments, and the ointment of rose-water; while the following are made by incorporation: belladonna, chrysarobin, iodine, iodoform, mercurial, nutgall, stramonium, sulphur, and veratrine ointments, and the ointments of ammoniated mercury, carbolic acid, lead carbonate, lead iodide, potassium iodide,

zinc oxide, red mercuric oxide, tannic acid, and yellow mercuric oxide.

Soft ointments may be very satisfactorily dispensed in *collapsible tubes*, like those used for holding artists' oil colors. (See Fig. 24.) The ointment is easily introduced in the large open end of the tube, and this then closed by folding the soft metal sides together; when it is desired to use some of the ointment the screw cap is removed and sufficient is pressed out. The advantages of this mode of dispensing are that the ointment is preserved from change by preventing the access of air, waste is avoided, as well as the greasing and soiling of furniture due to the passage of fatty oils through the ordinary wooden boxes that are often used to dispense ointments in.

Fig. 24.



Lanolin (the purified fat from sheep's wool), petrolatum, cosmoline, and vaseline (purified products from petroleum residues), have all been used as substitutes for lard and animal fats as bases for ointments; but unless otherwise specified, it is always understood that when ointments are prescribed purified lard is the basis.

The following methods of prescribing ointments are given as illustrations:

℞.
Ung. hydrarg. nit., ʒiij;
Ung. aq. rosæ, ʒv.
M. Ft. unguent.
Sig. Apply to the eyelid at night.
N. T.

℞.
Ung. stramonii, gr. xx;
Pulv. gallæ, gr. xxx;
Adipis, ℥ss.
M. Ft. unguent.
Sig. Apply as directed.
W. B.

℞.
Ext. belladon., gr. vj;
Petrolati, ʒiv.
M. Ft. unguent.
Sig. Apply as directed.
L. V.

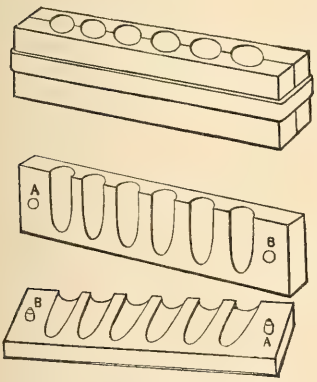
℞.
Hydrarg. ammon., gr. v;
Glycerini, gtt. v;
Adip. benz., ℥ss.
M. Ft. unguent.
Sig. Use as directed.
L. B.

℞.
Veratrinæ, gr. x;
Lanolini, gr. xxx.
M. Ft. unguent.
Sig. Rub on the part as directed.
M. M.

℞.
Ung. acidi gallici, ℥ss;
Ung. zinci oxidi, ʒiss.
M. Ft. unguent.
Sig. Apply night and morning.
D. B.

Suppositoria (Suppositories).—Suppositories may be described as solid medicated compounds designed to be introduced into the rectum, urethra, or vagina, serving the purposes of ordinary clysters or injections, over which they have the advantages of greater comfort and cleanliness, as well as being more easily introduced; their consistence is such that while they retain their shape at ordinary temperatures, they will readily melt at the temperature of the body. The material best adapted for use as the vehicle appears to be the oil of theobroma (butter of cacao), which possesses in an eminent degree both of the above requirements. A mixture of gelatin and glycerin has been successfully used as a vehicle, more particularly for urethral suppositories, butter of cacao being too brittle for convenient use. Glycerin suppositories, containing 95 per cent. of glycerin, are largely used. The size of suppositories has been gradually diminishing; formerly they were made to weigh from one to two drachms or more; in the Pharmacopœia of 1870 they were directed to be made to weigh thirty grains, while in the present Pharmacopœia their weight is directed to be about fifteen grains. In order that suppositories may be uniform in size and shape, they are generally run or pressed into moulds, which in the absence of metallic moulds may be made of sized paper folded into the shape of cones. They may also be made by hand by grating cacao butter with an ordinary grater, and then mixing in the medicinal ingredients in a mortar, adding, if necessary in cold weather, a drop or two of olive oil: the whole is to be made into a mass with a pestle and then rolled out in a cylinder on a pill-tile. The cylinder is then cut into suitable

FIG. 25.



Divided Suppository-mould.

FIG. 26.

FIG. 27.

Suppositor.

lengths for a suppository, and one of the ends is pointed by pressing it into shape gently with the finger and thumb.

Although no special suppositories are official, a general formula is

given for their preparation, in which the oil of theobroma is directed to be melted and then mixed with the medicinal portion. Fig. 25 shows a mould for making suppositories. It is made of brass, and the parts are held in place by a rubber band. Machines are now in use whereby handsomely finished suppositories are rapidly made by cold compression, the ingredients having previously been thoroughly mixed. Figs. 26 and 27 show a simple apparatus for introducing suppositories into the rectum. Fig. 27 is hollow, with its lower end reduced in diameter, so that the suppository fits snugly when dropped into it. This end is oiled and introduced into the rectum, the piston (Fig. 26) being used to push the suppository into its place.

Some of the modes of prescribing suppositories are as follows. Some allowance should be made for waste in moulding when the quantity of the basis is specified:

℞.
Ext. hyoscyam., gr. iv;
Ol. theobrom., q. s.
Fiat massa et div. in suppositoria No. iv (āā. gr. xv).
Sig. One at night. W. L.

℞.
Morph. sulph., gr. ½;
Ol. theobrom., q. s.
Fiat massa et div. in suppos. No. iv (āā. gr. xv).
Sig. One at night. T. T.

℞.
Iodoformi, gr. xvj;
Acid. carbolici, gtt. iv;
Ol. theobromæ, q. s.
Ft. massa et div. in suppos. No. viij (āā. gr. xv).
Sig. One, 3 times a day. E. M. D.

℞.
Acidi stearici, gr. lxxx;
Sodii carb., gr. xl;
Glycerini, ℥ij.
Misce. et fiant suppos. No. xij (āā. gr. lxxv).
Sig. One as required. M. L. T.

℞.
Ext. stramonii, gr. xij;
Plumbi acet., gr. xviij;
Creasoti, gtt. vj;
Ol. theobromæ, q. s.
Fiat massa et div. in suppositoria No. xij (āā. gr. xv).
Sig. Use as directed. R. T.

℞.
Quininæ sulph., gr. xvj;
Ol. theobrom., q. s.
Fiat massa et div. in suppos. No. iv (āā. gr. xv).
Sig. One, twice a day. B. H.

℞.
Ext. opii, gr. vj;
Hydrarg. chlor. mit., gr. xx;
Ol. theobrom., q. s.
Ft. massa et div. in suppos. No. xij.
Sig. One, 3 times a day. W. W.

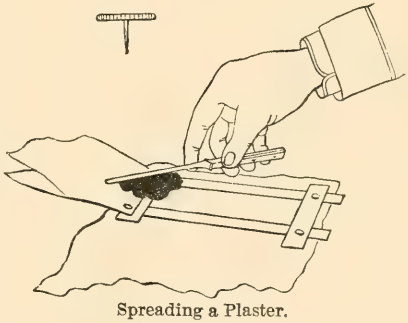
℞.
Ext. ergotæ, ℥ij;
Ol. theobromæ, q. s.
Ft. massa et div. in suppos. No. xij (āā. gr. xxx).
Sig. One at night. E. M. C.

Emplastra (Plasters).—The word "plaster" is applied both to the material of which plasters are made and to the spread plaster itself. Plasters are intended for external application, and the consistence of the material is such that it requires the aid of heat in spreading it, but is sufficiently soft and adhesive at the temperature of the body to adhere when applied to the skin. There is one exception to this definition of official plasters, and that is isinglass plaster—or court plaster, as it is familiarly called—which is a spread plaster, and does not become adhesive when warmed, but requires to be moistened with water before application.

The most ordinary basis for official plasters is lead plaster, while some owe their adhesiveness and consistence to resinous substances and others to gum-resins. Plasters are usually spread upon leather or muslin, sometimes upon paper. Sheepskin is the kind of skin commonly used; when greater pliability or softness is required buckskin or chamois-skin may be employed. A plaster when spread should be so firm as not to run or melt at the heat of the body, and yet should be soft, pliable, and adhesive. When long kept, plasters become hard and brittle and lose their adhesive properties.

The official plasters have in a great measure been superseded by ready-spread plasters having a rubber basis, which are manufactured of a great variety of kinds and in immense quantities. These plasters are pliable and adhesive, do not change their consistence, and retain their medicinal properties unimpaired for an indefinite length of time. Unfortunately, the process is not adapted to the wants and purposes of the pharmacist, and cannot be used advantageously except upon a very large scale.

FIG. 28.



Spreading a Plaster.

Fig. 28 illustrates the spreading of a plaster. The skin is laid upon a smooth, flat surface of wood and strips of writing-paper are tacked on, as shown, preferably with thumb-tacks. The melted plaster is poured on one end, and it is uniformly spread over the surface with a previously-warmed spatula.

The following list comprises all the official plasters: ammoniac with mercury, arnica, belladonna, capsicum, iron, mercurial, isinglass, opium, Burgundy pitch, cantharidal pitch, lead, resin, and soap.

Prescriptions for plasters are usually written in the following forms:

℞.
Emp. belladonnæ.
Spread a breast-plaster 8 inches in diameter. J. S.

℞.
Emp. pic. burg., 4×6.
Dust upon the surface sufficient powdered opium to adhere.
W. L. G.

℞.
Emp. capsici. 4×6.
Sig. Apply upon back, as directed.
K. T.

℞.
Spread a soap-plaster 2×8 inches, with a half-inch margin. D. D.

Chartæ (Papers).—"Papers" of the Pharmacopœia are preparations intended chiefly for external application, and consist of paper saturated or coated with medicinal substances. Only two "papers" are official: mustard paper and potassium nitrate paper; the last, in addition to being used externally in the shape of moxas, is much used in cases of asthma. It is sometimes called asthma-paper, and frequently affords relief. It is used by burning the paper and inhaling the fumes while burning.

Chartæ may be ordered in the following manner:

℞.
Chartæ sinapis., j.
3×4.
Sig. Apply immediately. W. V.

℞.
Chartæ cantharidis, j.
For the left ear, as per pattern.
Sig. Apply at once. E. S.

Incompatibility.

Incompatibility is that condition in medicines which results from the admixture of ingredients which are unsuited to each other. It is obvious that incompatibility may arise from a great variety of causes; and it would be impossible to enumerate all of the cases of incompatibility which are likely to occur in compounding medicines; indeed, it is impossible to give even a fair approximation of them. It must not be assumed that incompatibility is always unintentional: the decomposition of a chemical salt is sometimes the object sought by the prescriber. Nothing but a thorough knowledge of the physical and chemical properties of all of the substances which enter into the Materia Medica would absolutely prevent the prescribing of incompatible substances.

In order to grasp more clearly the various phases of incompatibility the subject is divided into three classes: 1. Chemical incompatibility; 2. Physical incompatibility; 3. Therapeutic incompatibility.

1. **Chemical Incompatibility.**—By this is meant the incompatibility which is due to chemical action, which results in decomposition of one or more of the ingredients of the prescription. This form of incompatibility is very common, and may be produced as follows:

1. *Through the precipitation of an insoluble salt by the addition of one solution or salt to another.*

2. *By the decomposition of a salt in solution containing a base united with a weak or volatile acid by the addition of a stronger acid.*

3. *Through the decomposition of a salt in solution containing an acid united with a weak or volatile base by the addition of a strong alkali.*

4. *By the precipitation of alkaloidal salts by the addition to their solutions of alkalies, alkaline salts, or salts which produce insoluble compounds.*

5. *By the unsightly discoloration or precipitation due to the formation of inky compounds, produced by bringing astringent solutions containing tannin or similar substances in contact with ferric salts.*

6. *By the decomposition of a substance without precipitation, because of the formation of products which are soluble in the resulting liquid.*

7. *By the decomposition of a salt in solutions containing a base united with a weak or volatile acid by the addition of a salt containing a stronger acid.*

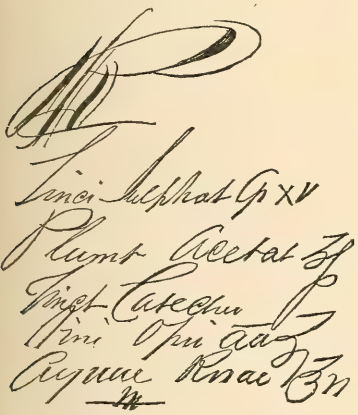
8. *By the decomposition of an oxidizing agent through the addition of organic or readily oxidizable substances, or by the destructive decomposition of some of the ingredients, with the formation of gases, resulting from the explosive action of the substances entering into the prescription.*

9. *By chemical action in the prescription, which results in an unexpected change in the color of the liquid.*

1. Through the precipitation of an insoluble salt by the addition of one solution or salt to another.

This is one of the most frequent forms of incompatibility. As before stated, some prescriptions are purposely constructed to yield precipitates; injections used in gonorrhœa are often so constructed (See Fig. 29). In this case the precipitated lead sulphate is the important factor. In prescription Fig. 30 a good illustration is afforded of this kind of incompatibility. Quinine sulphate forms with soluble acetates the insoluble quinine acetate; it is very doubtful whether any of the quinine acetate would be decomposed in the stomach, and a pharmacist would be justified in calling the attention of the prescriber to the character of the precipitate.

FIG. 29.



℞ FIG. 30.

Quin. sulph.,	ʒss;
Acid. sulph. dil.,	gtt. xx;
Tinct. card. comp.,	fʒij;
Liq. ammon. acet.,	fʒiij;
Aquæ, q. s. ad	fʒiv.

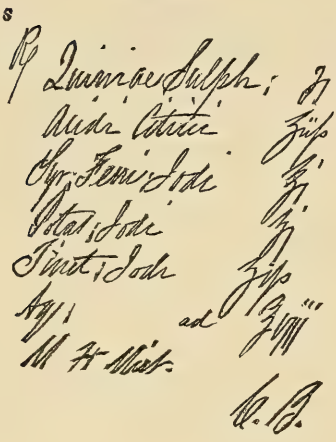
M.

Sig. Take a tea-spoonful 3 times a day.

G. W. N.

In prescription Fig. 31 a complicated reaction occurs. The citric acid is present in sufficient quantity to dissolve the quinine sulphate, but the iodides are decomposed, and the result is the formation of insoluble quinine iodide. The prescription, which is a facsimile, shows other evidence of lack of skill and judgment. The combinations of alkaloids and iodides or bromides should be avoided.

Fig. 31.



R. Fig. 32.

Sodii salicylat.,	ʒss ;
Acid. hydrochlor. dil.,	fʒiv ;
Syr. limon.,	fʒss ;
Aquæ, q. s. ft.	fʒij.

Ft. solutio.

Sig. A tea-spoonful 3 times a day.

L. L.

Prescription Fig. 32 shows a common form of this kind of incompatibility. The soluble salicylates are decomposed by acids, and salicylic acid, being almost insoluble in water, is thrown out of solution. The diluted hydrochloric acid should be prescribed separately.

2. By the decomposition of a salt in solution containing a base united with a weak or volatile acid, by the addition of a stronger acid.

R. Fig. 33.

Ammon. carb.,	ʒss ;
Tr. opii camph.,	
Syr. scillæ,	āā. fʒij.

Ft. mistura.

Sig. A tea-spoonful 3 times a day.

V. R.

Prescriptions having this fault are very common. In the illustration given (Fig. 33) the fact that syrup of squill contains acetic acid is usually overlooked, and if the pharmacist forgets this and compounds the prescription in the usual way, decomposition takes place in the bottle, the acid acts on the ammonium carbonate, and carbonic acid is liberated in sufficient quantity to burst the bottle. If the escape of gas is allowed to proceed quietly in the mortar before bottling, no harm will probably ensue. But if it is desirable to give an alkali in such a mixture, liquor potassæ, liquor sodæ, or liquor ammoniæ would be much preferable.

3. Through the decomposition of a salt in solution containing an acid united with a weak or volatile base, by the addition of a strong alkali.

This form of incompatibility is not so common as that last considered. It is seen in Fig. 34, which is a form of caustic sometimes

prescribed. When the strong alkalies are brought in contact with the ammonium carbonate, gaseous ammonia is liberated, until the latter is finally entirely dissipated.

4. By the precipitation of alkaloidal salts by the addition to their solutions of alkalies, alkaline salts, or salts which produce insoluble compounds.

Fig. 34.

℞

Calcis,	ʒiv;
Ammon. carb.,	ʒss;
Potassæ,	ʒij.

Ft. pulv.

Sig. Use cautiously, as directed.

M.

This represents one of the most dangerous forms of incompatibility that can occur. It is well known that the alkaloids are the most powerful and toxic of all of the agents used in the Materia Medica. The alkaloids, morphine, strychnine, quinine, etc., in their pure alkaloidal condition are soluble in oils, alcohol, ether, chloroform, benzine, and other similar solvents, and are mostly insoluble in water. As their aqueous solutions are the most useful in medicine, chemists have been compelled from their introduction to "salify" them, as it is termed; by this is meant the addition of the proper molecular portion of acid to convert the alkaloid into a salt; thus from morphine, by the addition of sulphuric, hydrochloric, and acetic acids, the sulphate, muriate, and acetate of morphine are formed. Now, it requires 10,000 parts of cold water to dissolve 1 part of the alkaloid morphine, but only 24 parts of the same liquid to dissolve 1 part of sulphate of morphine or muriate of morphine, and only half of this quantity, or 12 parts of cold water, to dissolve 1 part of morphine acetate; thus it follows by the laws of chemical action that if an aqueous solution of an alkaloidal salt is brought in contact with free alkali, decomposition takes place; the acid used in salifying the alkaloid combines with the added alkali, and the alkaloid in its pure state is precipitated. If the solution is strong and the alkali in excess, the precipitation is immediate, and would be apt to be noticed at once by the apothecary; but the alkaloids are rarely given internally in strong solution, and the particular danger lies in the fact that the precipitation of a colorless, transparent alkaloid takes place very gradually in the prescription, and without attracting any attention from the patient after it has left the hands of the pharmacist. The patient is likely in such cases to get no effect from the morphine in the first doses of the medicine, but when the last tea-spoonful is swallowed the quantity of morphine, which should have been distributed equally and the proper amount taken with each dose, *is all taken at once*, and death is likely to ensue. Several cases have been reported in which serious results have followed; and whenever such a prescription is received by a pharmacist, it is his duty to place what is known as a "shake-well" label upon the bottle; but as these labels are often disregarded through carelessness of the

patient, it is never safe to trust to such a course, and such prescriptions should never be written.

The soluble bromides and iodides form with many of the alkaloidal salts bromides and iodides which are insoluble, and hence they should never be prescribed together; the taking of the accompanying prescription (Fig. 35) caused the death of a lady some years ago in Great Britain.

℞ Fig. 35.

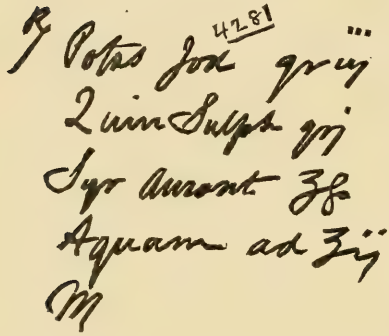
Strychniæ sulph.,	gr. j;
Potassii bromid.,	ʒvij;
Aquæ, q. s. ft.	fʒviij.

M. Ft. solutio.

Sig. Take a tea-spoonful 3 times a day. W. R.

For an hour or two after this prescription is prepared there are no signs whatever of decomposition, but after standing for a greater length of time a precipitate of colorless crystals forms in the bottom of the bottle, and in the case above noted the patient took the last tea-spoonful of the mixture with nearly the whole quantity of the strychnine. The pharmacist who compounded the prescription was ignorant of the chemical reaction which took place, or he might have saved her life by directing the mixture to be shaken. Fig. 36 is a facsimile of a one-dose prescription in which the chemical reaction takes place, with the formation of quinine iodide; no danger, however, can occur in the administration of this dose, for none of the ingredients are poisonous in the dose ordered.

Fig. 36.



5. By the unsightly discoloration or precipitation due to the formation of inky compounds, produced by bringing astringent solutions containing tannin or similar substances in contact with ferric salts.

Instances of incompatibility of this class are very frequent; indeed, it is difficult to avoid the formation of inky precipitates, owing to the almost universal presence of tannin in vegetable substances. Fig. 37 illustrates a prescription of this kind. The cinchotannic acid in the cinchona forms an insoluble inky compound with ferric chloride, and the tannate of iron produced communicates a blackish appearance to the mixture which renders it very unsightly.

℞ Fig. 37.

Tinct. ferri chlor.,	fʒij;
Ext. cinchon. fld.,	fʒss;
Syr. tolut.,	fʒiss;
Aquæ, q. s. ft.	fʒiv.

M. Ft. solutio.

A tea-spoonful 3 times a day. V. T.

Astringent drugs usually owe

their astringency to some form of tannin, and it is therefore safest to avoid combining iron salts with such preparations.

6. By the decomposition of a substance without precipitation, because of the formation of products which are soluble in the resulting liquid.

It must not be supposed that chemical decomposition does not take place when substances are brought in contact, because there is no *outward indication* of a change. Precipitation, it is true, is a common evidence of decomposition, but decomposition may take place with the effect of producing *soluble* compounds, or at least such as are not plainly visible; such a prescription may be seen in Fig. 38. In this case the free alkali will attack the chloral hydrate, decompose it, and produce soluble compounds, some of which are volatile, and the prescription gradually loses its strength.

℞ FIG. 38.

Chloral. hydrat.,	℥ss;
Liq. potassæ,	f℥iv;
Potassii brom.,	℥ij;
Syr. zingib.,	f℥iv.

M.

Sig. A tea-spoonful at night.

W. M.

Alkalies are known to act on some of the alkaloidal drugs injuriously, and it is said that fluid extract of ipecac loses its emetic power if combined with free alkali. Fortunately, this kind of incompatibility is not likely to produce serious effects, as instances of the decomposition-products becoming more poisonous than the original substances are rare.

7. By the decomposition of a salt in solution containing a base united with a weak or volatile acid, by the addition of a salt containing a stronger acid.

This kind of incompatibility resembles very much that treated of in paragraph 2, but on account of the decomposition being produced by a salt instead of an acid, the cause of the difficulty is more liable to escape notice. Two illustrations (Fig. 39 and Fig. 40) are appended, in which explosions occurred, after the mixtures were placed in bottles ready for dispensing. In Fig. 39 the natural acid salts present, or more probably the acidity of the extract of taraxacum (which increases with the age of the extract) was the cause of the explosive action. The course which would be likely to be followed by the pharmacist would be to rub the extract with the liquids until the whole mixture is smooth, and then the solid ingredients would be incorporated gradually, and the mixture dispensed without a suspicion that upon

℞ FIG. 39.

Pulv. rhei,	℥ss;
Magnes. carb.,	℥ij;
Ext. taraxaci,	℥iv;
Tinct. gent. comp.,	f℥ij;
Aquæ,	ad f℥vj.

M. Ft. mistura.

Sig. A tea-spoonful 3 times a day.

L. F. T.

standing the carbonate would be gradually decomposed by the acids present. And when sufficient carbonic acid gas had accumulated the cork would be blown out of the bottle or the bottle itself burst into fragments. If the acidity of the extract be first overcome by neutralizing it with a few drops of any simple alkaline liquid, the difficulty is overcome. In Fig. 40 a very different form is shown. This case calls for special knowledge. Syrup of ferric chloride owes its preservation and effectiveness largely to the presence of an acid salt, together with a slight excess of hydrochloric acid; and when the prescription is allowed to stand tightly corked for a short time, an explosion is certain to occur, owing to the decomposition of the ammonium carbonate and the liberation of carbonic acid. In this case the alkaline salt should not be dispensed in combination.

FIG. 40.

℞ Ext. pulsatillæ fld., gtt xv;
Ext. digital. fld., f℥j;
Liq. potas. arsen., gtt x;
Ammonii carb., ʒij;
Syr. ferri chlorid., ad f℥iv.
Misce.
Sig. Half a tea-spoonful 3 times a day.
N. N.

8. By the decomposition of an oxidizing agent through the addition of organic and readily oxidizable substances, or by the destructive decomposition of some of the ingredients, with the formation of gases resulting from the explosive action of the substances entering into the prescription.

This form of incompatibility occurs frequently, notwithstanding the many warnings that have been issued in the various professional journals, both medical and pharmaceutical. Two substances are responsible for nearly all of the accidents that occur in this way—potassium chlorate and potassium permanganate. They both readily part with their oxygen, and cautious treatment must be the rule if accidents are to be avoided. The safest course is to establish the habit of prescribing all such substances by themselves, without attempting combinations, except those of a very simple character. Fig. 41 exhibits one of these prescriptions. It exploded, notwithstanding the fact that great caution was observed in mixing the ingredients.

FIG. 41.

℞ Calcii hypophos.,
Potassii chlor., *āā.* ʒss.
M. Ft. pulv. No. vj.
Sig. One to be taken 3 times a day.
V. Q. L.

The hypophosphites, even in solution, have been known to explode violently, and in one case a workman in a large chemical laboratory was killed from an explosion resulting from the evaporation of a concentrated hypophosphite solution, and the cause for it has never been satisfactorily explained. But when two bodies known to evolve large quantities of gas under the influence of chemical action, like the two in the above prescription, are ordered, it is proper for the pharmacist

promptly to decline to compound the mixture. These substances may be powdered separately, and mixed together cautiously on paper with a spatula, and yet explode simply upon standing. Potassium chlorate can be mixed with sugar without difficulty by mingling both with a spatula, if they have been dried previously and finely powdered; but care must be taken not to strike such mixtures powerfully with a pestle in a mortar, for the concussion is often sufficient to cause explosions.

Fig. 42.

℞.

Ext. nuc. vom.,	gr. ij;
Ext. aloes. aq.,	gr. xij;
Potas. permang.,	gr. xij.

M. Ft. pil. No. xij.

Sig. One, 3 times a day.

℔.

Fig. 42 illustrates a prescription for pills which exploded after being compounded.

9. By chemical action in the prescription, which results in an unexpected change in the color of the liquid.

Very frequently chemical action is indicated by a change in the color of a liquid prescription. If this occurs after it has left the apothecary's hands, it is sure to occasion remark, and sometimes alarm, on the part of the patient, who is led to believe that some error in compounding has produced the change in color. Tact and judgment should be used by the physician in accounting for these changes, otherwise the reputation of the pharmacist may suffer from an unjust accusation. Mixtures of guaiac containing spirit of nitrous ether or a trace of nitric acid become blue upon standing a short time. This has led many patients to think that the pharmacist has by mistake introduced some copper into the prescription. A few days' or weeks' exposure to the air will sometimes change the character of a substance, so that a prescription put up with the fresh substance will have a different appearance from one compounded from the same substance a week or a month later. Rhubarb, for instance, contains resinous principles and chrysophanic acid; these are affected by alkalies, the reddish-brown color changing to a deep purple. This may be noticed taking place very gradually in the official compound powder of rhubarb. When the rhubarb, magnesia, and ginger are first mixed together the mixture is of a light fawn color, but on standing a few months, particularly if one of the powders has not been perfectly dry, the color changes to a rose color. This is due to the action of the alkali magnesia upon the resinous principles of the rhubarb. The change in color produced when an alkaline solution is added to a liquid preparation of rhubarb —the infusion, for instance—causing it to become dark red, illustrates the rapid action of the alkali upon these principles. Then, again, the coloring matter in many drugs and preparations is discharged by bleaching agents—chlorine, sunlight, bromine, sulphurous acid, etc. etc. Tincture of iodine may have its color removed

by various methods, as the addition of ammonia water, carbolic acid, and sodium hyposulphite. Incidentally, it might be mentioned that the attempt to refine the tincture of iodine, by taking away its objectionable feature of staining the skin, results in taking away the iodine itself, for it is no longer present in the free state, and in the case of the addition of ammonia the physician might as well prescribe the external application of a solution of ammonium iodate and iodide.

It would be impossible in the space allotted to this subject to enumerate all of the possible changes in color that are likely to occur in prescriptions. It may be mentioned, however, that acids brighten the red vegetable colors or give them an orange tint, while alkalies cause them to assume a brown or green color; yellow vegetable colors are darkened or turned brown by the addition of alkalies, acids restoring the yellow color, or having in the first place little or no effect upon the original yellow solution. Green vegetable colors are often changed to yellow with acids, alkalies giving them a yellowish-brown color. Blue and violet vegetable colors are reddened by acids, and either become brown when alkalies are added, or, as in the well-known litmus, become blue again.

It is well to observe the changes in the color of prescriptions due to chemical action, but, as a rule, the medicinal activity of substances is not impaired by the change.

Physical Incompatibility.—By this term is meant the condition that is produced by bringing substances into contact which, through the action of physical forces, are dissociated. It differs from chemical incompatibility by the absence of chemical action, and the evidences of physical incompatibility in liquid prescriptions are mostly shown in the precipitation of some of the principles which were in solution in the original liquids. These principles may be active or inert, and thus physical incompatibility may result in the frustration of the intentions of the prescriber, or it may produce consequences which have no significance whatever. It is on the accurate judgment of the apothecary in such matters that the most dependence must be placed, for he must have sufficient knowledge of the physical properties of the various salts, solutions, and preparations to be able to detect almost instantly the cause of precipitation in a mixture, and apply a remedy which will in no way affect the intention of the prescriber, but at the same time supply the demand for satisfactory pharmaceutical preparations. A good illustration is afforded by Fig. 43, for in this case the valuable portion of the prescription would stick resolutely to the sides of the bottle, and the object of the prescription would be entirely brought to naught, if the apothecary did not come to the rescue and apply one of the simplest rules of his art—namely, the "blending of substances which are diverse into one harmonious whole." The resin of guaiac, which dis-

solved in alcohol forms the tincture, would of course be thrown out of combination when mixed with water and syrup, and the patient would simply take a tea-spoonful of diluted syrup of liquorice. In such a case the addition of a little gum acacia by the apothecary would emulsify the tincture of guaiac and hold all of the ingredients together, so that the patient would get in each tea-spoonful the proper proportion of each ingredient.

℞. Fig. 43.

Tr. guaiaci,	f℥iij ;
Syr. glycyrrhizæ,	f℥iv ;
Aquæ, q. s. ft.	f℥ij.

M.

Sig. A tea-spoonful 3 times a day.

T. S.

Fig. 44 illustrates another form of physical incompatibility. The medicated waters are mostly saturated solutions of volatile oils in water, and peppermint-water is no exception. The quantity of potassium bromide here is sufficient to destroy the affinity existing between the oil and the water, and when the solution of the bromide is effected the oil goes out of solution and the liquid becomes opaque from the drops of separated oil. If the peppermint-water be diluted with an equal bulk of water, no difficulty occurs.

℞. Fig. 44.

Potassii brom.,	℥vj ;
Aq. menth. pip.,	f℥xij.

Ft. solutio.

Sig. Half a tea-spoonful at night.

N. G. K.

℞. Fig. 45.

Tinct. nuc. vomicæ,	f℥ss ;
Tinct. gentianæ comp.,	f℥ij ;
Tinct. cinchon. comp.,	f℥vss.

M.

Sig. A tea-spoonful 3 times a day.

G. W. T.

Fig. 45 shows a form of physical incompatibility in which the separated substance is inert; in such cases it is usual to filter the mixture. Care should always be taken by the dispenser to satisfy himself that the precipitate is inert before filtration; if doubt exists, the prescription should always be dispensed *unfiltered* with a "Shake" label. In this prescription precipitation occurs almost immediately, but the precipitate is composed of inert matter, and is caused mainly by the fixed oil in the tincture of nux vomica and the pectinous matter in the compound tincture of gentian. Strong alcohol is the menstruum used in making the tincture of nux vomica, diluted alcohol that for the compound tincture of gentian, while that used for the compound tincture of cinchona is 80 parts of alcohol, 10 parts of water, and 10 parts of glycerin. It must follow that when such tinctures are mixed some precipitation occurs, but in this case there is sufficient alcohol and water present to retain the active principles of each in solution, and filtration is admissible. Some conception of the extent of the knowledge of the physical and chemical characteristics of medicinal substances

necessary to meet the emergencies of prescription-work is afforded by due consideration of chemical and physical incompatibility.

Therapeutical Incompatibility in prescriptions is the condition produced by the injudicious combination of medicinal substances that are therapeutically opposed to each other.

The combinations of therapeutic agents which are intended to produce certain results form appropriate subjects for consideration elsewhere in this work, and hence are not treated of in this place. The following table of incompatibles may be found useful, although necessarily brief; it is of course impossible to compile a table to cover all combinations:

Brief Summary of Incompatibilities.

Acid arsenious, with lime-water, ferric oxide, magnesia.

Acids generally, with alkalies, acetates, metallic oxides.

Albumin, with acids, alcohol, tannin, corrosive sublimate.

Alkaloidal salts generally, with tannin, alkalies, alkaline and earthy carbonates, iodine and its compounds, liquorice, strong mucilages, alkaline and ammoniated tinctures.

Alum, with alkalies and alkaline carbonates.

Ammonium bromide, with mineral acids, alkaline carbonates, chlorine, potassium chlorate and bichromate, silver nitrate, calomel.

Amyl nitrite, with tinctures, alkaline carbonates, calomel, lead salts, ferrous salts, potassium iodide.

Apomorphine (*hydrochlorate*), with sodium carbonate and bicarbonate, salts of iron, iodine, and tannin.

Barium chloride, with sulphuric and phosphoric acids and their salts, tartrates, and carbonates, medicinal wines, and vegetable infusions.

Bismuth subnitrate, with tannin, sulphur, antimony sulphide, calomel.

Chloral hydrate, with water (slow decomposition), warm water, alkaline carbonates, vegetable alkalies, ammonia salts, mercuric nitrate, calomel.

Potassium chlorate, with mineral acids, organic substances, sulphur, carbon, calomel, ferrous iodide, etc.

Chlorine (*chlorine-water*), with alkalies, alkaline carbonates, salts of ammonia, vegetable salts, silver nitrate, lead salts, tannin, vegetable mucilages, extracts, waters, infusions, tinctures and syrups, milk, and emulsions.

Corrosive sublimate, with carbonates, lime-water, potassium iodide, opium, vegetable infusions, tannin; but compatible with lime, barium, and strontium carbonates.

Digitalis, with tannin, sugar of lead, iodine, potassium iodide, alkaline carbonates.

Golden sulphide of antimony, with sodium bicarbonate, cream of tartar, calomel, bismuth subnitrate.

Gum arabic, with ferric chloride, lead salts, alcohol, ethereal tinctures, borax.

Iodine, with ammonia, starch, metallic salts, fatty or essential oils, emulsions, chloral, earthy carbonates, gum arabic, tragacanth, salep.

Iron, powdered (*iron reduced by hydrogen*), with aloes, vegetable infusions and extracts, tannin, metallic and alkaloidal salts.

Iron salts, with alkaline carbonates, vegetable infusions and extracts, tannin, mucilage.

Lime-water, with acids, carbonates, ammonia, salts, metallic salts, tartrates, infusions, tinctures, tannin.

Musk, with acids, acetates, tannin, ergot of rye, metallic salts.

Opium, with alkaline carbonates, salts of the metals, tannin, iodine, chlorine-water, and nux vomica. Although opium and belladonna are supposed to be physiologically incompatible, they are often administered together with good results.

Pepsin, with alcohol, tinctures.

Potassium permanganate, with organic substances.

Salicylic acid and sodium salicylate, with iron salts, potassium iodide, lime-water.

Silver nitrate, with hydrochloric, sulphuric, acetic, and tartaric acids and their salts, hydrocyanic acids and its compounds, iodine, potassium iodide and bromide, alkaline and earthy carbonates, sulphur and antimony sulphide.

Sodium bicarbonate, with acids, tannin, salts of the metals and of the alkaloids.

Strophanthus (*tincture*) in water undergoes hydrolysis, with formation of a toxic substance.

Tannin, with mucilage, all metallic salts, lime-water, alkaline carbonates and bicarbonates, egg-albumin, gelatin.

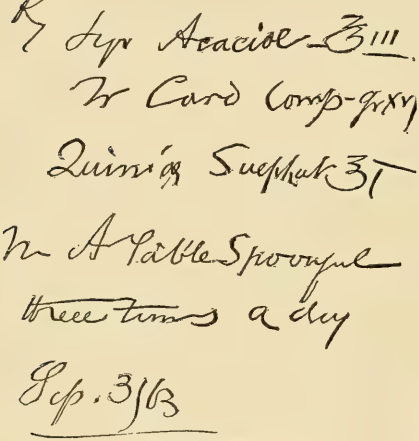
Tartar emetic, with acids, alkalies, soap, calomel, tannin, rhubarb, cinchona, gum arabic, opium.

Faults in Prescription-Writing.

The following *facsimiles* are a few selected from the author's work on *The Practice of Pharmacy*, 2d ed., p. 1017. They are presented with the view of showing some of the more prominent faults in prescription-writing. They are exact reproductions of prescriptions taken from active files, and they give some idea of the perplexities and difficulties besetting the life of the apothecary, who necessarily must be an expert in deciphering all kinds of marks on paper. Fig. 46 shows a

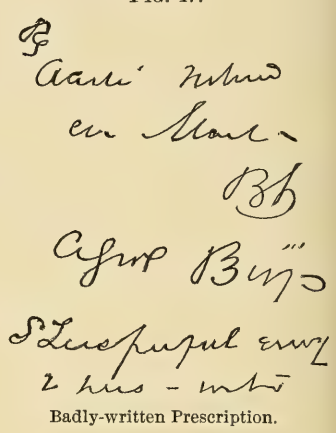
common fault; it is known as "transposition," and is caused by the habit which many physicians have of writing down the ingredients first and then placing the quantities in afterward. In this case the marks were transposed: "gr. xvj" should have followed "quiniæ sulphat," and "ʒj" should have been placed after "Tr. card. comp." In a glaring case like this the apothecary would usually correct the prescription, and notify the prescriber of his action if the circumstances were such that he could see the physician personally and have the correction made without the patient's knowledge. This would be his proper course, but such action often means a loss of time that would be very inconvenient, to say the least. Of course where the supposed transposition is not so evident the duty of the pharmacist is clearly one of non-interference, and he would not be justified in dispensing the prescription without revision from the author.

Fig. 46.



Transposed Prescription.

Fig. 47.



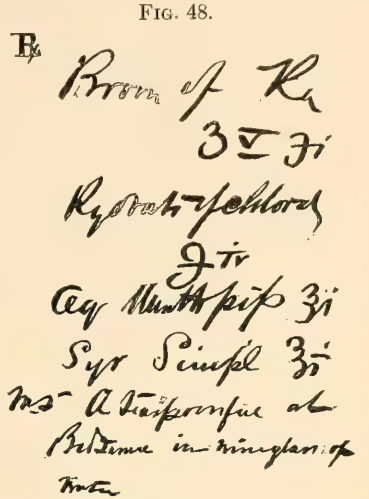
Badly-written Prescription.

In Fig. 47 is seen not only bad writing, but the fault of not using a whole line for a title, as well as that of not using official names for preparations. In this case the prescriber wanted "Acidum nitro-hydrochloricum," or, in the old nomenclature, "Acidum nitro-muriaticum," but having forgotten, or possibly having never known, the correct title, he writes "Acidi nitric et muriat., fʒss." This fault often leads to perplexities not easily solved.

Fig. 48 shows the same fault of not using a full line for each ingredient and quantity, as well as the careless habit of employing chemical symbols for abbreviations, with the use of Latin and English terms hopelessly mixed. Fortunately, there can be no question as to the intention of the writer here: he wishes 320 grains of bromide of potassium and 80 grains of hydrate of chloral, dissolved in a mixture of

1 fl. ounce each of peppermint-water and simple syrup. Incidentally, it may be stated that the official name for "syrup" is "syrupus," and not "syrupus simplex." The name "simple" syrup has not been authorized since the Pharmacopœia of 1820. Surely seventy years is long enough to get rid of a bad habit. There is no more necessity for using the term "simple" before syrup than before alcohol, glycerin, or any other liquid used to make both simple and compound preparations, it being understood that when the word "compositus, -a, -um" is not affixed the "simple" preparation is wanted. For the same reason "simple" cerate and "simple" elixir are misnomers.

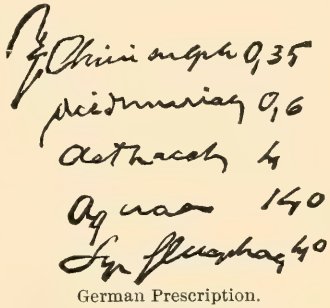
FIG. 48.



Odd Prescription.

Fig. 49 shows an involved German prescription. This is of course metric, recognized at once by the use of Arabic numerals instead of Roman characters. This prescription is not volumetric, but gravimetric, and the liquids are to be weighed instead of measured. The last ingredient is puzzling for even a bright son of the "Fatherland." The translation is, thirty-five centigrammes of sulphate of quinine (chin. sulph.), sixty centigrammes of hydrochloric acid, four grammes of acetic ether, one hundred and forty grammes of water, and forty grammes of syrup of orange-flower (fl. naphæ). The advantages of metric prescription are plainly shown here, notwithstanding the indistinctness of the ingredients, for there are no puzzling, ℈, ʒ, and ℥ marks to worry over, and the figures indicating the quantities cannot be mistaken.

FIG. 49.



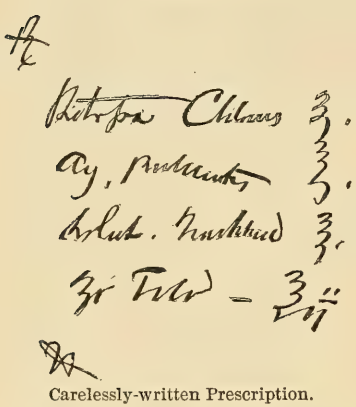
German Prescription.

Fig. 50 illustrates how "hurry" mars the appearance of a prescription. The writer has quickly scratched down the ingredients, and then in putting down the quantities, all in a row at once, has run them together, so that the whole is difficult to decipher. One ounce of potassium chlorate is to be dissolved in a mixture of one fluidounce each of boiling water and solution of morphine, and two fluidounces of syrup of tolu.

Fig. 51 shows faults of a serious character: improper abbreviation has caused loss of life a number of times. "Hyd Chlor" may mean

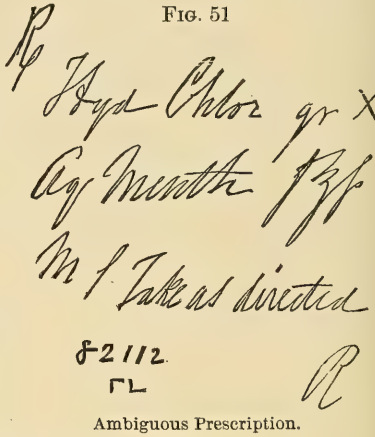
calomel, corrosive sublimate, or chloral hydrate. The dispenser who "jumps at" conclusions might imagine that a soothing draught of

Fig. 50.



Carelessly-written Prescription.

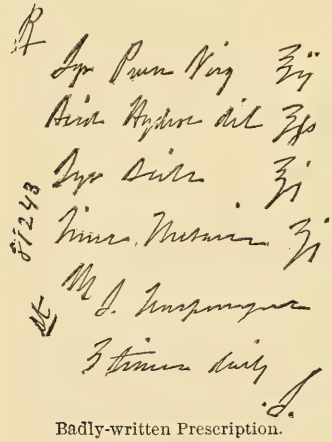
Fig. 51



Ambiguous Prescription.

chloral hydrate and mint-water was intended, and that verbal directions were given to the patient how to take it; but the careful pharmacist would ask the patient whether he wanted the directions put on the label, and what the directions are: this brings the information that it is a dose for biliousness, and the doctor said "to take the whole quantity at once." This surely does not mean that either chloral hydrate or corrosive sublimate was wanted, but calomel, and so it proved to be. Mint-water might mean either peppermint-water or spearmint-water, and a memorandum should be made of the ingredients on the prescription at the time that it is compounded, so that in case of renewal the patient will receive exactly what he did originally.

Fig. 52.



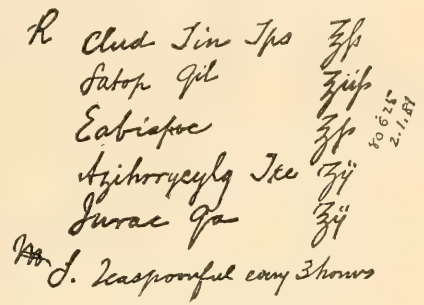
Badly-written Prescription.

In Fig. 52 is seen an illustration of one having several common faults. The use of antiquated terms is sometimes excusable, particularly when the intention is to prevent the patient from translating the ingredients. Thus, "Tinct. thebaici" is a name sometimes used instead of "Tinct. opii." Indistinctness, hurry, evidences of improper abbreviation are the principal faults, however. The prescriber wishes two fluidounces of syrup of wild cherry, half a fluidrachm of diluted hydrochloric acid or diluted hydrocyanic acid (the dispenser will have to guess at this, refuse the prescription, or see the doctor; it happened that diluted

hydrocyanic acid was wanted here, as it was for a cough mixture), one fluidounce of syrup of squills, and one fluidrachm of tincture of opium.

Fig. 53 shows what is termed a travestied prescription: it has been contrived so that the uninitiated might not be able to compound it. A physician writing such a one would tell the patient to take it to a certain druggist; of course he had previously arranged with the druggist the terms and the secret. No difficulty is experienced in compounding it if the names of the ingredients are spelled backward. The writing of such a prescription is inexcusable; no reputable physician would ever be guilty of issuing it, for even if it is not intended to get from the patient an additional fee (but merely written to prevent the patient from reading it), it bears a most suspicious "ear-mark."

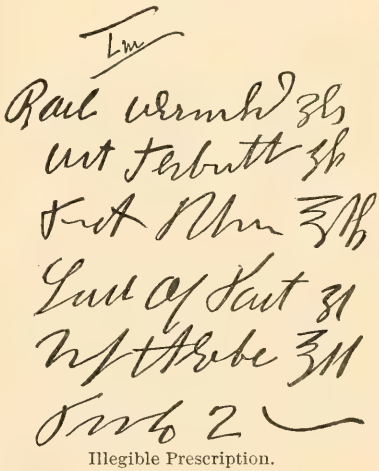
Fig. 53.



Travestied Prescription.

Fortunately for the pharmacists of Philadelphia, no more prescriptions quite like that shown in Fig. 54 are produced at present. The physician who wrote it had a very large practice, but seemed entirely to ignore all standards and rules in writing prescriptions. Fig. 54 is by no means the worst specimen in the author's collection, but a fair idea of the prescriber's style may be gleaned from it. He intended half a fluidrachm of oil of wormseed, half a fluidrachm of oil of turpentine, half a fluidounce of tincture of rhubarb, one drachm of "salt of tartar" (potassium carbonate), two fluidounces of mucilage of acacia (mu. arabe). The hieroglyphics at the bottom mean "A tea-spoonful every 2 hours." It will be noticed that Latin and English synonyms are hopelessly confused, and obsolete terms, faulty abbreviations, misspelled words, and nearly all of the sins on the calendar, have been committed.

Fig. 54.



Illegible Prescription.

Fig. 55 represents a dangerous abbreviation. It will be seen that it is an addition to a prescription, and, although the physician who wrote the prescription is usually a careful prescriber, there is ambiguity

about the fluid extract that he wishes to add to "29468." Is it fluid extract of jalap or fluid extract of jaborandi that is to be added? It proved to be jaborandi, and it was necessary to return the prescription to its author before the point could be settled.

FIG. 55.

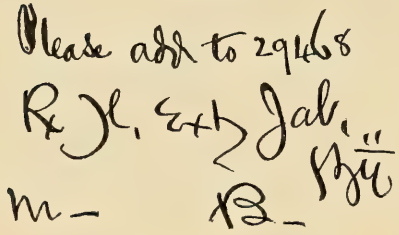


Fig. 56 is not shown as a specimen of bad penmanship or as an example of illiteracy, for the characters are fairly well formed, the terminology is above the average, and no ambiguity is noticed about the ingredients, but the number of the latter is startling: polypharmacy of a most pronounced type is here discovered. The physician who wrote it is a firm believer in compound prescriptions, and the author has in his collection two more prescriptions written by the same prescriber, each containing as many ingredients as seen in Fig. 56. Of course there can be no attempt made to indicate the therapeutic action of such a mixture.

FIG. 56.

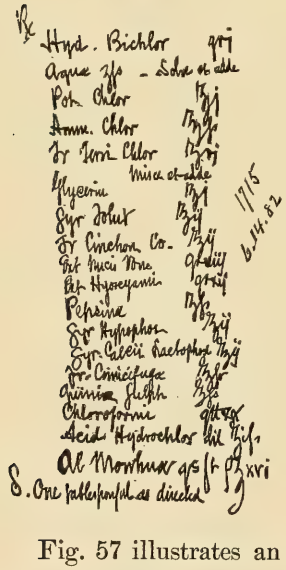
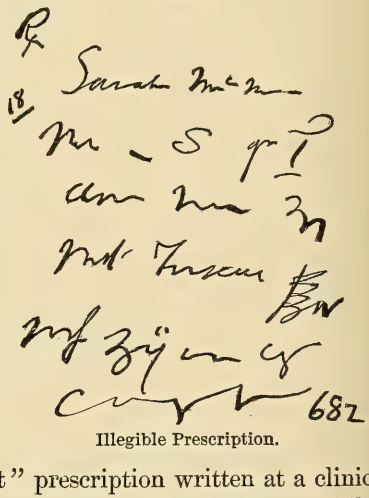


FIG. 57.



Illegible Prescription.

Fig. 57 illustrates an "out-patient" prescription written at a clinic by a physician in a hurry. It fortunately fell into the hands of a skilful and conscientious pharmacist (since deceased), who had been in the habit of reading such scrawls, and he had no difficulty in translating it in this way: "For Sarah McM——. Morphine sulphate, one grain; ammonium muriate, one drachm; brown mixture, four fluid-ounces. Take two tea-spoonfuls in water for a cough."

GENERAL SANITATION.

By HENRY B. BAKER, A. M., M. D.

Recently there has been great progress in several sciences contributory to sanitary science—that science which forms the basis for intelligent and successful public-health administration. This is especially true of those biological sciences which deal with the microscopic causes of diseases. There has been progress also in knowledge gained through mortality statistics, heretofore the main basis for practical sanitation. In one or two localities advances have been made through sickness statistics. But progress has been made in other lines of accurate knowledge concerning the causation, modes of spreading, and measures effective for the prevention and restriction of diseases.

Much of this advance is a result of extensions and outgrowths of the medical sciences. The sanitary sciences are, largely, advanced medical sciences, and require for their complete mastery a well-grounded knowledge of medical science. Therefore, although not all physicians may wish to enter the public service as sanitary officials, leading sanitary officials must generally be physicians.

Owing partly to the rapid increase of knowlege useful for the prevention of disease, the numbers of sanitary officials are rapidly increasing, and in the immediate future they should still more rapidly increase. This field of labor is a very attractive one, for several reasons: the studies are intensely interesting, leading as they do into new fields of scientific investigation, and yielding knowledge of such surpassing importance to mankind. The fame of a Jenner, a Pasteur, or a Koch may not be gained by every investigator in such fields, but whoever does successful work in such directions merits, and is likely to receive, the homage of grateful humanity in whose behalf the work is done.

From a social-science standpoint the prevention of disease is much more economical than is its cure. Sooner or later the people generally will recognize this fact, and then there will be a general demand for sanitarians, and these should, in great part, be recruited from the ranks of medical practitioners.

Eminent men in the medical profession have prophesied that in the future the duties and labors of physicians generally will become more largely preventive than curative of disease. While this may prove to be true, it would seem to be more in harmony with the general laws of

progress that there should first occur a division of labor—a separation of the profession into specialties, one portion being devoted to preventive, and other portions to the several branches of curative, treatment. It seems to be admitted, however, that a broad culture in all of the medical sciences supplies a good basis for the training of a specialist in any branch of medical practice; and preventive measures are expected to apply to every disease treated by any specialist. The general good of mankind therefore calls for an interest in, and some knowledge of, sanitary science and its practical application in public-health work on the part of every physician.

The purpose of this essay is to give a general view, such as every physician should have, of the essentials in applied sanitary science.

The Evidence that Sickness and Deaths can be Prevented.—The evidence is of several kinds, and is entirely conclusive. There is not room for all of it here, but some of it may be referred to, as follows:

1. It is well known that, coincident with the generally improving sanitary conditions, there has been a gradual increase in the average duration of human life throughout the past history of civilized man.

2. A few hundred years ago leprosy was a common disease in Great Britain; the map of England was dotted over with leper hospitals. Apparently through even such imperfect isolation as was practised leprosy decreased until now it is a very rare disease in that country.

3. Not many years ago scurvy was a very common disease. Its causes became known, preventive methods were adopted, and now it is a rare disease.

4. In many countries, through drainage of the soil, clearing of forests, and lessening of stagnant surface waters, there has been a very great reduction of the sickness from intermittent fevers.

5. In many countries, apparently through better conditions of living, better housing, drainage, foods, etc., there has been a reduction of the mortality from consumption, as shown by the vital statistics.

6. In some countries the reduction of the mortality from consumption has followed or was coincident with measures, such as drainage, etc., which tended to make a drier, and consequently a warmer, soil about residences. This was proved by Dr. Henry I. Bowditch in Massachusetts and by Dr. Buchanan in England. Dr. Pepper's work in Pennsylvania may also be mentioned in this connection. But so long as the most important cause of consumption remained unknown, the most important measures for its prevention could not be adopted. Now that this is known, and is coming to be generally accepted, the general prevention of consumption seems to be practicable. All the measures that in the past have been proved to be effective should be continued, and the additional measures which are now apparent through the important discovery of the specific cause of the disease should be

promptly adopted. What these measures are will be dwelt upon farther on in this article.

7. The wonderful reduction of the mortality from smallpox which has followed the methods established by Jenner is well known.

8. The comparative recent immunity from cholera in this country is probably due to improved measures for the prevention of its introduction and spreading in this country.

9. The comparative recent immunity from yellow fever in some of the Southern States of this Union is probably due to the improved quarantines at New Orleans and other ports, and to sanitary measures, such as those inaugurated in Memphis, Tenn., by the National Board of Health and since maintained and added to by intelligent citizens of Memphis.

10. One of the most remarkable instances of the recent almost complete local extinction of a disease through sanitary measures is that of typhoid fever in Munich, Bavaria, described farther on in this article.

11. The record of the great saving of human life and health in Michigan in recent years, apparently through systematic work for securing coöperation of neighbors of infected premises, for the restriction of communicable diseases, is one to which the State and local boards of health in Michigan can justly point with pride. It is a record of the saving of over one hundred lives per year from smallpox, four hundred lives per year saved from death by scarlet fever, and nearly six hundred lives per year saved from death by diphtheria—an aggregate of eleven hundred lives per year, or three lives per day, saved from these three diseases.[1]

Diseases which are Preventable.—Several diseases which in times past swept people off the earth are no longer to be feared; they are demonstrated to have been "preventable" diseases.

There can now be made a list of important diseases which have been restricted or prevented over such a considerable area or in so many localities that there can be little if any doubt that they are "preventable" diseases. Such a list would include smallpox, cholera, yellow fever, scarlet fever, and diphtheria.

It is apparent that the diseases which first came under the control of man were those which were most noticeably communicable. Isolation of the infected persons and things and crude methods of disinfection were practised far back in the dim past. Such methods were sufficient to do away with some diseases. More careful and skilful application of those same methods have sufficed to restrict some of the most important diseases of the present time. Thus, it has been

[1] In a carefully-prepared paper, read before the Sanitary Convention at Vicksburg, Michigan, the proceedings of which are published by the Michigan State Board of Health, the writer gave official statistics and evidence which he thus summarized.

demonstrated that by isolation and disinfection, by such methods as was recommended by a State board of health, scarlet fever and diphtheria have been restricted, so that at least four-fifths of the cases and deaths which would otherwise occur have been prevented.[1]

It is apparent that those communicable diseases which, like tuberculosis and diphtheria, were not recognized as communicable, would not be brought under control. That seems to be the reason why to-day, throughout the world, consumption is the cause of more deaths than is any other disease. But the history of sanitation in the past would seem to guarantee that as soon as the modes of its spreading are generally known that disease will decline, as similar diseases in times past have declined, leprosy being the disease most comparable to tuberculosis. The history of smallpox may throw doubt on this promise, because until vaccination was discovered and adopted the disease was not prevented or materially restricted. Yet it is now claimed that the human race is intelligent enough to restrict smallpox by isolation and disinfection without the aid of vaccination. Vaccination has been demonstrated to be so useful and so harmless a measure that it is to be hoped that, until boards of health are much better supported than they have been, no such dangerous experiment will be tried, over a very considerable proportion of the world's inhabitants, as would be the general neglect of vaccination. But, granting that smallpox was prevented only through vaccination, it does not seem too much to expect that tubercular diseases will in some way soon become rare. Such accurate knowledge of the subject as we now possess should enable us to restrict almost entirely all diseases due to the *Bacillus tuberculosis.*

Theoretically, all specific diseases should be considered to be preventable; also, theoretically, all dietetic diseases, such as scurvy and alcoholism, should be considered preventable. Man's control over such influences as atmospheric temperature should soon be sufficient to enable him to prevent diseases due to such conditions. Finally, all diseases which cause premature deaths should be considered to be preventable, and efforts should be made to gain such knowledge of their causation as will enable man to adopt the proper measures for their prevention.

The Creation of Sanitary Science necessarily a Governmental Function.—Among the most important bases for practical sanitation are morbility statistics, mortality statistics, and tabulated records of experience in sanitation. Neither of these three important bases can be supplied by individual effort. For the recording, collecting, tabulating, and publishing of such data legal provision is essential; and if the work stops here, it will, as a rule, fail to reach a useful stage. It is needful that there shall be governmental recording, col-

[1] This is mentioned farther on, in connection with evidence on the subject (Figs. 67 and 68.)

lecting, tabulating, and publishing of the conditions of the atmosphere and of other agencies controlling the causation of diseases; and before such knowledge is available for practical usefulness there must be a bringing together, comparison, and study of the results of these several groups of facts in ways to show conclusively the relations which meteorological and other conditions sustain to each of the important diseases. All the factors in the causation of diseases cannot otherwise be learned, and without complete knowledge of the causation of a disease efforts for its prevention are hampered. General sanitation requires, first of all, then, legal provision for systematic governmental action for continuous morbility statistics, mortality statistics, and records of experience in sanitation.

The practical application of sanitary science has two closely-related objects: the prevention of premature deaths and the prevention of unnecessary sickness. It does not follow that the most sickness and the most deaths are both from the same disease; and in some parts of this country the most sickness results from a disease which causes few deaths.

Morbility Statistics.—The relative importance of the various diseases as causes of sickness can be learned in only a few States or cities in this country. It can be learned so far as relates to the regular armies in most countries. Sickness statistics are very valuable for many purposes, and especially for comparison with statistics of meteorlogical and other conditions for the purpose of learning the causation of diseases.

In Michigan, under the direction of the State Board of Health, there is a system of scientific collective investigation of disease whereby, through weekly reports of the sickness under their personal observation, leading physicians throughout the State supply data which for many years have been tabulated and graphic curves drawn, so as to exhibit plainly the relations which about all the most important diseases sustain to nearly all of the most important meteorological conditions. This illustrates how it is possible to learn the conditions under which each of the various diseases increases, and those under which each disease declines, in prevalence. Such knowledge is essential to any complete system of general sanitation. It seems almost past comprehension that, in this country, in this enlightened age, such work has been systematically done in only one State.

Mortality Statistics.—It is obvious that without mortality statistics sanitarians would be "in the dark" as regards knowledge of progress, lack of progress, or the special direction of most need for effort. This is not a treatise on vital statistics, and little need be said on this subject here, but every physician is interested in having a fair idea of the condition of health in his own city or locality and in comparing States and localities. In order to make such comparisons one must be sufficiently familiar with the methods of statisticians to be able to inter-

pret their mortality reports; and, owing to the diversity of methods, this is sometimes quite difficult. Some of the most usual methods are here mentioned.

Relative to a given disease the death-rate is sometimes stated by the hundred, thousand, ten thousand, one hundred thousand, or million inhabitants of the city, state, or country, living at the middle of the year.

The death-rate from all causes is generally stated per one thousand inhabitants per annum. And this is the rule for mortality statistics published each month or each week. It is important that such a rule be generally adopted, so that at a glance one can see how the death-rate in any given city, in any given week or month, compares with that in other cities, with that in the other weeks or months in the year, and with the annual rate. Many intelligent people, however, fail to read the death-rate correctly when it is correctly stated. If for a given week or month the death-rate is stated as "22 per thousand per annum," what is meant is that if the same rate as prevailed in that week or month were to prevail throughout the entire year, the death-rate would be 22 per thousand inhabitants living at the middle of the year.

In this country there is not exact uniformity in methods of stating, or even in methods of computing, the death-rate, each health officer or statistician feeling at liberty to employ his own method. In the office of the Registrar-General of England—and probably also throughout England—in obtaining the death-rate for a given week the practice is said to be about as follows: "Divide the actual population by 52.17747—the number of weeks in the exact year[1]—and with the quotient thus obtained divide the product of the actual weekly deaths multiplied by one thousand." Perhaps the subject would be better understood by some persons if the formula were differently stated, as, for instance: Multiply 52.17747—the weeks in the year—by the actual deaths during the week, and divide the product by the number of thousands of inhabitants.

Where the statement of the death-rate is for a month, the formula might be: Divide 365.24226 by the number of days in that month, multiply the quotient by the number of deaths, and divide the result by the number of thousands of inhabitants.

The Principal Causes of Deaths.—The answer to this question is not the same in every State in this Union. Thus, in Michigan the five diseases which cause the most deaths, arranged in order by numbers of deaths, are—consumption, diphtheria, pneumonia, typhoid fever, scarlet fever. In Memphis, Tennessee, judging from the statistics for the year 1889, consumption causes the most deaths, and pneumonia next; but malarial fever is fourth on the list, and should really be considered third as a cause of mortality.

[1] The exact year being 365.24226 days.

Some idea of the importance of the practical application of sanitary science to the prevention of disease may be seen in the fact that each one of the five diseases which cause the largest number of deaths in Michigan is believed to be a preventable disease, and, excepting pneumonia, about which there may still be doubt, the practical measures for their restriction and prevention are already quite well known to leading sanitarians. There are also several other important diseases for the prevention of which effective methods are known.

The Prevention of our Present Most Important Diseases necessarily a Governmental Function. — Private or personal hygiene is good, but it is entirely inadequate to prevent any of those diseases which now cause most deaths. It is probably useful, but not effective, against consumption; of very little use against diphtheria or scarlet fever; useful, but not protective, against pneumonia and typhoid fever. For protection against the dangerous communicable diseases the general co-operation of all classes of people is essential. Each person is so continuously exposed, directly and indirectly, to other persons in all ranks of life that no person can live to himself alone; the safety of each is bound up with the safety of others, so that each individual has a vital interest in the general health and in general and special measures for the safety of the public health. The public health, then, must be guarded by public officials. Disraeli said: "The health of the people is the first duty of the statesman."

In organization and methods the public-health service should, in my opinion, conform to the organization and methods for other governmental purposes. In this country, where the people rule, the principle of local self-government is important for purposes of public sanitation. There can be no such thorough co-operation as is required among all classes of people unless all classes of people appreciate the importance of such action; and they cannot appreciate the importance of such action unless they are informed on the subject. For progress in general sanitation it is essential that information on the subject shall be general, and that the general information shall be sufficient to enable the people to appreciate the work of the local health officer.

Wherever practicable, as in townships, villages, and small cities, it is desirable that the same local officers who control the appropriations of money shall be the local board of health, or at least shall be in such relation to the board of health that they shall become familiar with its needs. Otherwise, the health service will generally be crippled for lack of money to do what is needed to be done. If the officers who control the money are the same to whom the people look for proper public-health work, they will, as a rule, be more likely to provide sufficient money to carry on the work. In townships the township board or other officials who control the township affairs should be the board

of health. But this board of health should have a health officer, who, wherever this is practicable, should be a physician. In villages the board of trustees, board of aldermen, or whatever the village board may be called, should be the board of health if no other board of experts is actually organized. In cities there should be a special board of health, composed of sanitarians, or at least of physicians or professional men, with an expert sanitarian for health officer.

The general co-operation of citizens for the prevention of disease should be required by law: notification of the occurrence of a dangerous communicable disease should be compulsory upon every householder, the notice to be given to the health officer, and it should be required to be given nearly as promptly as is the ordinary alarm of fire, because the danger is to life, whereas in the case of fire it is more frequently only to property.

The health officer should have ample authority, force, and means, and the law should require him, under penalty, promptly to enforce strict isolation of all known infected persons and things; to give notice of every known infected place to all concerned, by a placard on the infected premises, and otherwise when necessary; to control and supervise any and all movements of infected persons and things; to allow no public or other vehicle used for transporting infected persons or things to be used again except after thorough disinfection; to have all infected premises disinfected before permitting their occupancy by uninfected persons; to control all funerals and burials of persons dead from any cause.

These methods are applicable for the restriction of smallpox, diphtheria, scarlet fever, and perhaps other diseases. For the restriction and for the prevention of other diseases other measures are important, which may be briefly mentioned here, and at greater length elsewhere.

For the prevention of smallpox the most important measure is vaccination and revaccination. For the prevention of typhoid fever proper sewerage and water-supply are important.

The construction of buildings should be under expert supervision as to ventilation, heating, lighting, house-drainage, etc. The water-supply should be under expert supervision as to source, etc., and from time to time be examined chemically and biologically. For the prevention of consumption, that most important of all diseases, there should be not only destruction or disinfection of all sputa, but expert supervision of sites for buildings, drainage of sites, ventilation of dwellings, and especially of all public buildings. For the prevention of rheumatism hygiene is useful, but there is need for the general instruction of all classes of people as to its causation, the proper diet, and prevention of exposure. For the prevention of neuralgia similar instruction is needed. Systematic records of sickness from rheumatism, tonsillitis, neuralgia, and similar troubles, and of coincident conditions,

conjoined with advances in pathology, now make it possible for sanitarians to give such instruction. But such knowledge has not been, and probably will not be, collected and elaborated by local boards of health. The collection and the dissemination of such knowledge are, more properly, functions of the State board of health.

State Boards of Health.—The proper organization of the public-health service requires the co-ordination of the work of all local boards of health, through the agencies of State and National boards of health.

The State board of health is preferable to the State health officer or commissioner of health, for several reasons, one of which is as follows: A State health officer or commissioner of health must be, almost necessarily, a political officer, subject to frequent change at the dictation of party interests. No such officer would be likely to remain in office long enough to become thoroughly conversant with the varied duties of chief executive officer of health.

The chief executive officer of health for a State should be—what no man can become except through long-continued study and experience—an expert in the several branches of sanitary science and in public-health administration. He should be a sanitarian and also a social scientist. He should also be thoroughly conversant with all laws of his State relating to measures needed to be employed in the public-health service. He should be an expert statistician. He should be a thorough meteorologist. He should be especially skilled in those sciences which contribute to a knowledge of the etiology of diseases. He should be a well-educated physician, with special talents for scientific studies and investigations. He should have considerable knowledge of the physical sciences, especially of chemistry.

The requirements for the position are so extraordinary that few persons in other pursuits could be expected to fulfil them at once and without experience. Since experience is so important, measures for ensuring freedom from change for political reasons, and permanency of position so long as the duties of the office are properly performed, are correspondingly important. Permanency of position during proper performance of duty should be provided for by a law that shall so declare. But even a law to that effect can be strengthened by providing as near as may be a non-partisan board of health, whose members shall be the judges whether the chief executive officer of health is faithfully performing the duties of his office. And the members of such a board, consisting of the leading sanitarians of the State, are better qualified to select, in the first instance, the person who is likely to prove an efficient executive officer than would usually be the governor and senate of a State. A State board of health is therefore an important agency for securing and for maintaining for the State a proper chief executive officer of health. This is only one of many reasons for the

existence of a State board of health, but it would seem to be a sufficient reason; and, to the writer, the other reasons are even more evident and apparent. The stability of the State board is increased if the terms of office of its members are long and do not all expire at the same time. If there are six members, the terms may be seven years, two members retiring every two years. But with members of the board, as with the chief executive, experience is valuable, and the reappointment of faithful members is desirable, although without that, if a majority of the board continue in office, something like continuity and permanency is attained.

Old and New Views of General Sanitation.—There was a time when the most enlightened public view of the subject of general sanitation included not much more than the abatement of nuisances and the restriction of smallpox. Indeed, at the present time one great hindrance to progress in general sanitation is the inertia in the minds of the people, due to this same old idea. Too generally the functions of a board of health or of a health officer are supposed to be the abatement of such nuisances as powerfully appeal to the sense of smell, sight, or hearing. We know, however, that the important diseases which are spread by ordinary filth are few compared with those which are spread by particulate "specific" causes which cannot be recognized by any of the senses unaided. The specific causes of some of the most dangerous diseases have no odor. They are not visible, except through the aid of the microscope or of some special method of cultivation. Sanitarians have learned the causes of "the pestilence which walketh in darkness and wasteth by noonday," and are able to set forth to the people methods which will undoubtedly be effective for the prevention of the "pestilence" (tuberculosis) that causes more deaths than any other, and of several other pestilences which, like diphtheria and scarlet fever, rank only a little below that great white plague. There is, therefore, need no longer for being so exceedingly "afraid of the dark," as may be termed that fear of filth which has been so general. Not that filth does not cause disease: it may do so; at least there are diseases which, if they are not caused by filth, are so intimately associated with it that an enlightened avoidance of filth is preventive of the disease. This is true of cholera and of typhoid fever, and probably true of yellow fever.[1]

One of the most graphic exhibits of the relations of filth to cholera and to typhoid fever is that prepared by Dr. Joseph von Fodor of Budapesth, who tabulated the results of his investigations and study of the subject in Buda-pesth for a period of fifteen years (1863–1877), as follows:[2]

[1] If it were not for accidental inoculations, tetanus also might be included in this statement, because the specific cause of tetanus is so frequently associated with dirt about stables and with garden soil.

[2] "Ueber den Einfluss der Wohnungensverhältnisse auf die Verbreitung von Cholera und Typhus," *Archiv für Hygiene*, 1884, Seite 269.

Typhoid Fever and Cholera in Buda-pesth, 1863–77.

1. *Influence of filthy houses:* Deaths from cholera per 100 houses when the interior of the dwelling was	1. Very clean	92
	2. Clean	199
	3. Dirty	268
	4. Very dirty	402
Deaths from typhoid fever per 100 houses when the interior of the dwelling was	1. Very clean	165
	2. Clean	177
	3. Dirty	182
	4. Very dirty	356
2. *Influence of filthy yards:* Cholera deaths per 100 houses when the yard was	1. Very clean	188
	2. Clean	214
	3. Dirty	263
	4. Very dirty	389
Typhoid-fever deaths per 100 houses when the yard was	1. Very clean	159
	2. Clean	186
	3. Dirty	208
	4. Very dirty	282

Yet even cholera is not with certainty prevented by such action as results from a blind fear of filth. Knowledge of the specific cause of the disease and of its conditions of reproduction and destruction is useful for teaching the best measures for the prevention of cholera, the most important measure being the destruction or disinfection of the specific micro-organism which causes cholera. This "most important measure," disinfection, is to be treated separately and thoroughly in this volume by Dr. Sternberg; therefore it is not necessary to give details here, and we may pass on with the general principles of sanitation.

Is "Cleanliness Next to Godliness" in Sanitation?—A terse phrase is useful whenever it strongly presents a great truth. It may, however, become a great hindrance to progress when it conveys strongly an idea which falls far short of the truth. The phrase "cleanliness is next to godliness" has long been used to convey an idea that ordinary cleanliness, as the term is commonly understood, is the end and aim, the sum and substance, of sanitation. The idea, thus conveyed, was once held by some of the leaders in sanitary affairs, but it is now known to be false, and for several years it has stood in the way of progress. The only way whereby it can be held to be still true is by greatly modifying our views of what constitutes cleanliness. I have endeavored to illustrate this as follows: "The housewife has one standard of cleanliness, which requires that a dish for the table must be thoroughly washed with soap in hot water, rinsed with clear water, and drained or wiped dry with a clean cloth. If such a clean dish be given to the chemist for his most accurate work, he may object that the dish is not chemically clean, and he will rinse it in alcohol or in a strong acid or a strong alkali, according to the particular form of matter which he fears makes it unclean for his purposes, and after

rinsing and wiping or drying it he also will pronounce it clean. If this same dish, which has been made clean enough for the chemist, be given to the biologist who is experimenting on the vitality or reproduction of bacteria, he will pronounce it unclean for his purposes, and he will not be satisfied until he has submitted it to boiling water for at least five minutes or in dry air to a temperature of 240° or 250° F., and then he will require that it shall not be exposed for an instant to the ordinary air, for fear of its contamination by germs which sometimes float in the air. He will insist on these conditions because he has found by experience that ordinary cloths, ordinary air, and ordinary water generally contain bacteria, spores, or germs capable of reproduction under favoring conditions, and sometimes contain germs capable of reproduction in the bodies of human beings and of causing such diseases as smallpox, scarlet fever, and diphtheria."[1]

It is plain that what ordinary persons know as a clean plate, a clean article of clothing direct from the laundry, a piece of new goods from the store, or any of the ordinary articles which we consider "clean," may have received, and may convey, the specific cause of any of the most dangerous diseases.

In modern sanitation a fundamental idea, which it is important that every person should grasp, is that the "germ theory of disease" is now established on a firm scientific foundation; and this supplies a scientific basis for modern sanitation.

What a Health Officer should Know.—In order to be an intelligent and efficient health officer a physician should have clear ideas of the nature of contagia, of the conditions of their existence and reproduction within and without the body, of their destruction (disinfection), and of the means by which they are disseminated. Inasmuch as the specific causes of diseases are invisible to the unaided eye, the sanitarian must have and cultivate that "scientific use of the imagination" which will enable him to follow the dissemination of the contagium of each of the most important diseases, whether it goes out with the excreta and leaches into wells from which drinking-water is obtained, or with the sputa, and eventually rises into the air with the dust from floors or is spread through the air with the desquamations from the skin. He should constantly be able to bring before him a mental image of each micro-organism believed to be the specific cause of an important disease. He must at least master the idea that these contagia are "particulate." One way to do this is to consider vaccine virus as a form of contagium in mass sufficient to be seen by the eye. "If we imagine this to be made up of minute granules of rounded outline, so minute that twenty thousand of them in line will be required to extend an inch in length, we shall have an idea which will aid the

[1] *Report Michigan Board of Health*, 1880, p. 121.

mind in following the course and spread of disease-germs of this nature. We can then easily understand how such disease-germs may be floated off by the air, carried in a veil, scarf, or handkerchief, be stored or conveyed in the clothing, beard, or hair, appear as dust in a room, be sent in a letter or a paper, be boxed up and transported to a distance, washed off in water, carried into a privy, pass through the entire length of a sewer or the water-pipes which supply pure water, go in the milk-can on its round from house to house, or with the delivery-man from the grocer, baker, market, or laundry. This may serve to give us an idea of some of the problems with which the sanitarian has to deal in connection with the restriction and prevention of communicable disease, and some idea of what a health officer should know."

The Causation of Inflammations.—Recent advances in surgery, through practices originally based upon the "germ theory of disease," the methods being at first denominated "antiseptic surgery," and now "aseptic surgery," have led to a broadening of our view of the causes of inflammations. In addition to the causes of inflammations formerly dwelt upon, it seems to be established that there must be included certain micro-organisms which are very widely distributed in all thickly-settled communities—micrococci, sometimes grouped by twos and in chains—the *Streptococcus* or the *Staphylococcus pyogenes*, of which there are three varieties, the *albus*, *aureus*, and *citreus*, giving rise respectively to the white, the yellow, and the green pus. It is claimed that if these be kept out of wounds pus does not form, inflammation does not occur, and the wounds heal.

Sanitation in surgical hospitals must take account of the recent advances; and here also cleanliness is important, but simply that of the past is not fully adequate: there is required such knowledge of the sources and the nature of the micro-organisms, the conditions of their vitality and of their destruction, as will make it possible to guard against them.

Through complete disinfection of walls, floors, and contents of hospitals, including instruments, etc., and of the clothing and persons (especially the hands) of the operators, attendants, and visitors, it is now claimed that not only hospital gangrene and such inflammations as erysipelas may be prevented from attacking surgical patients, but all inflammations are prevented, provided the patient and the air-supply are not infected.

If, as is claimed, these micro-organisms are an important factor in nearly all inflammations, "aseptic" methods must be applicable to the prevention, not only of surgical inflammations, but traumatic inflammations, and, in fact, all inflammations, except possibly those inflammations due to such specific causes as the *Bacillus tuberculosis*, the

Bacillus diphtheriæ, etc., in which cases it might be true that the ordinary pus-generating micro-organisms were without influence. It seems to be proved, however, that even in those most important diseases due to specific causes the pus-generating micro-organisms are important factors. Therefore, all measures for securing an aseptic atmosphere are important. These measures should include the destruction of all sputa, the disinfection of all pocket-handkerchiefs, and the special care of all suppurating surfaces on man and on animals. "Since nearly all suppurative inflammations are breeding-places for micro-organisms, which, when they gain entrance into another living body (or into another weak or injured spot in the same body), are capable of again starting the inflammatory process, therefore should not all purulent discharges and all pus which is accessible be destroyed or disinfected? Should not the aim be thus to restrict the spread, and eventually to stamp out, all inflammations?"[1]

How the Specific Causes of Diseases Enter the Body.

In order best to guard against the introduction of the specific cause of a disease it is needful to know the most usual mode of its entrance into the body. As regards the most important diseases this knowledge is now available. Future discoveries may change our views on some of the points, but, according to what is now known to the writer, the most usual modes of entrance are as follows:

Typhoid Fever.—The specific cause of the disease is reproduced in the intestine, and probably in other parts of the body, being found in the spleen and other organs. The characteristic lesion in the lower portion of the small intestine indicates, perhaps, in what part of the body the specific cause is most generally destructive of tissue. Probably it most frequently leaves the body with the discharges from the bowels. But it having been learned that in about 30 per cent. of cases of this fever the urine contains the Eberth bacillus, now considered to be the specific cause of typhoid fever, it seems quite possible that the urine is frequently the most dangerous source of the spread of the disease. It has been suggested that the bacillus which causes typhoid fever is morphologically the same as a bacillus commonly inhabiting the large intestine of persons in health. If it is really the same, and its destructive and toxic powers, when it gains entrance into the small intestine, are due to the more favorable conditions there for its existence and to greater absorption of its ptomaïne, a good and sufficient reason is found for the existence of the ileo-cæcal valve, also for the disinfection or safe disposition of all human excreta. Experiments are needed to prove whether the inhalation of the dust from dried human excreta from persons not having typhoid fever will cause typhoid

[1] "Sanitation in 1890," *Trans. Am. Pub. Health Assoc.*, 1890.

fever. That typhoid fever is sometimes contracted by inhalation of the specific micro-organism seems to have been proved. If the usual method of disposal of human excreta should be changed from that of the water-carriage system or that of moist storage in vaults to that by drying and its conversion into dust, possibly the most usual mode of spread of typhoid fever might be changed. At the present time, however, the weight of the evidence is to the effect that typhoid fever is usually introduced into the body by way of the stomach and intestine. Drinking-water contaminated with fæcal or urinary discharges is believed to be the most common source or vehicle of typhoid fever. While the possibility of its originating in other ways is not denied, the frequent outbreaks of this disease which are traceable directly and unmistakably to a contaminated water-supply seem to point to this as the chief source of danger. The disease has been traced to milk diluted with infected water, and apparently in some cases to emanations from sewers and cesspools; also, apparently, to food infected by the feet of flies. The well-known outbreak of typhoid fever at Plymouth, Pennsylvania, where over 1000 cases and 114 deaths occurred, is apparently an illustration of how great a calamity may follow the fouling of a *general* water-supply by the discharges of a person sick with typhoid fever.

Diphtheria.—The specific cause of diphtheria (the Klebs-Löffler bacillus) may gain a lodgment on any part of the body where there is a broken surface, but ordinarily it does so in the throat. As a rule, it does not enter the general circulation in the human body; what enters is the poison evolved by the bacillus. The disease is most prevalent in the autumn and winter months, there being in Michigan twice as much sickness from it in November as there is in July. This indicates that exposure to the inhalation of a cold atmosphere increases the danger of contracting diphtheria; yet the disease does not sustain, by months, exact quantitative relations to the atmospheric temperature, the maximum sickness in Michigan occurring before the occurrence of the coldest weather. It is quite probable that the opening of the schools in the autumn is a cause of an increase in diphtheria, so that its maximum amount is in November (Fig. 58).

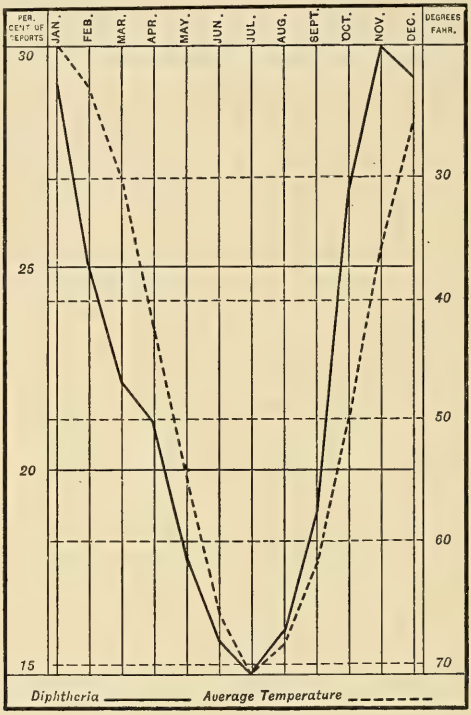
Scarlet Fever.—We have not a thoroughly verified knowledge of the exact nature of the specific cause of scarlet fever, but we have much useful knowledge of its behavior. In the first columns of Figs. 66 and 67 is evidence of the number of cases of diphtheria and of scarlet fever which occurred in outbreaks in which nothing was done to restrict these diseases; the figures relate to townships, villages, and small cities; and it has been found that under such conditions and during a series of years about fifteen cases occur of each of these two diseases—that is to say, these diseases spread to almost precisely the

same extent, indicating that both spread and are contracted in the same manner. We know that diphtheria is spread from the throat

FIG. 58.

SICKNESS FROM DIPHTHERIA, AND TEMPERATURE, IN MICHIGAN.

By months, for a period of nine years (1877–85), the relation of *Sickness* in Michigan from *Diphtheria*[1] to the *Average Atmospheric Temperature*. (The temperature curve is reversed; the scale increases downward.)



of the sick person to the throat of the person infected; the evidence tends to the belief that scarlet fever does the same; because if spread, as formerly believed, by the particles given off from all the surfaces of the body, scarlet fever should spread to a greater extent than diphtheria, which is not the fact. The specific cause of scarlet fever is probably reproduced in the throats of patients, and may be disseminated with the sputa; and, inasmuch as drying does not destroy the vitality of this contagium, the dust of the dried sputa should be considered dangerous. All the excretions should be disinfected. The most common mode of entrance of the contagium into the body of the person who contracts scarlet fever is by inhalation of the particulate, specific cause, and lodgment and reproduction of the specific

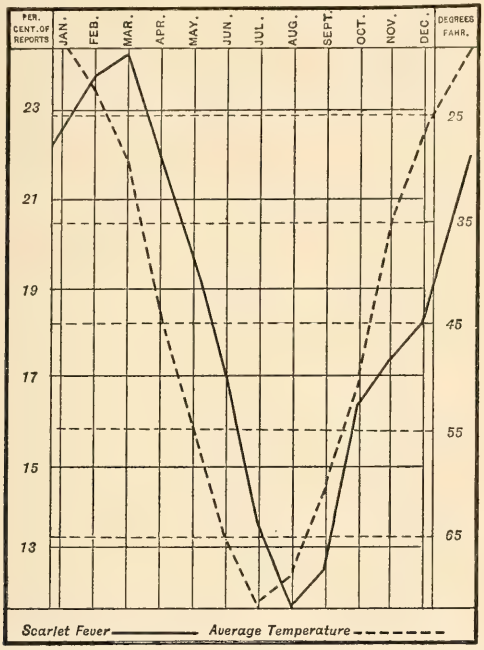
[1] Per cent. of reports which stated that diphtheria was under the observation of the physicians who made reports.

particles in the throat of the victim. If the foregoing is a correct outline of the usual methods of its dissemination, the disease, primarily, is local, a sore throat, but it is rapidly spread throughout the body. Fig. 59 shows that its maximum prevalence is after the coldest month, and its minimum after the warmest month.

FIG. 59.

TEMPERATURE AND SICKNESS FROM SCARLATINA, IN MICHIGAN.

By months, for a period of ten years (1877–86), the relation of *Sickness* from *Scarlet Fever*[1] in Michigan to the *Average Atmospheric Temperature*. (The temperature curve is reversed; the scale increases downward.)



Over 41,000 weekly reports of sickness and over 190,000 observations of the atmospheric temperature are represented in this diagram.

TUBERCULOSIS.—The *Bacillus tuberculosis* probably usually enters the body with the air inhaled, it being disseminated by the dust of dried sputa. Curves representing the amount of sickness and the number of deaths, by months, prove that consumption increases after the cold season of the year, and decreases in the warm season; as a rule, reaching its maximum in the spring and its minimum in summer or autumn (Fig. 60). Undoubtedly, the disease is sometimes contracted through the use of milk and meat of tuberculous animals, and occasionally through inoculation.

INFLAMMATORY RHEUMATISM.—The curve representing the rise

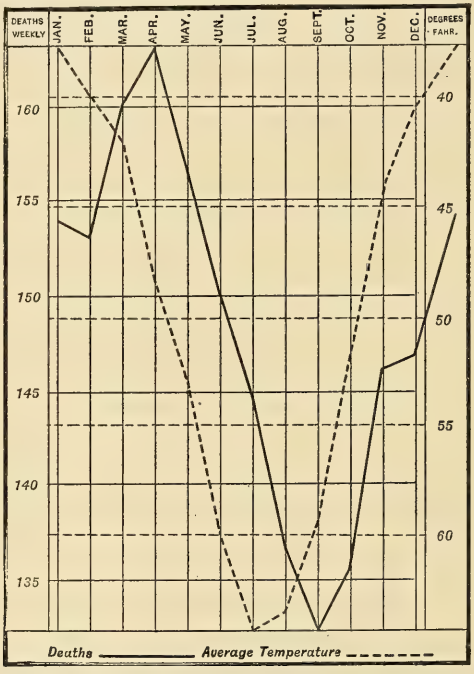
[1] Per cent. of reports which stated that scarlet fever was under the observation of the physicians who made reports.

and fall of rheumatism, by months, shows it to follow, with considerable regularity, the rise and fall of atmospheric temperature.[1] The curve for rheumatism follows the curve for tonsillitis. Clinical observers have noticed and recorded an apparent relationship between tonsillitis and rheumatism; and although most of them have concluded that the tonsillitis was rheumatic, the fact that usually tonsillitis precedes rheumatism seems to indicate that if there is a causal relation between the two diseases, tonsillitis is the most likely to stand as the first link in the chain. In tonsillitis and other inflammations of the

FIG. 60.

TEMPERATURE, AND DEATHS FROM PHTHISIS, IN LONDON.

By months, for a period of thirty years (1845–74), the relation of average *Deaths* per week, in London, England, from *Phthisis*, to the *Average Atmospheric Temperature*. (The temperature curve is reversed; the scale increases downward.)



About 231,000 deaths from Phthisis are represented in this diagram, data for which are from *Jour. of Scottish Med. Soc.*, New Series, Nos. xliii., xliv., xlv., xlvi., pp. 252 and 263.

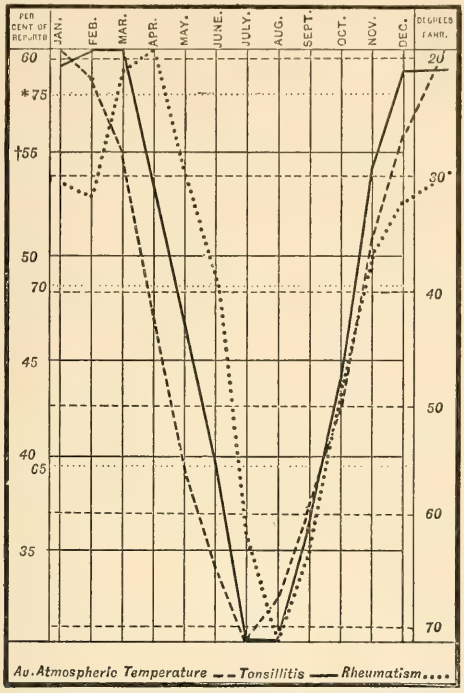
throat there is in the throat an increase in those same pus-generating micro-organisms which are found in inflammatory rheumatism; there is, therefore, increased opportunity for such micro-organisms to gain entrance to the body at times when sore throat prevails. So far as rheumatism is an inflammatory disease, its cause is probably generally introduced by way of the inflamed area in the throat or air-passages.

[1] This is shown by Fig. 61.

FIG. 61.

TONSILLITIS FOLLOWS TEMPERATURE; RHEUMATISM FOLLOWS TONSILLITIS.

By months, for a period of ten years (1879-88), the relation of *Sickness* in Michigan from *Tonsillitis* and *Rheumatism*[1] to the average *Atmospheric Temperature*, and the relation of Rheumatism to Tonsillitis. (The temperature curve is reversed; the scale increases downward.)



* Scale for rheumatism. † Scale for tonsillitis.

The Determining Cause of the Entrance of Specific Diseases into the Body.—It is useful to hold in mind the general principles relating to the entrance of specific causes of diseases into the human body:

1. A few diseases, such as smallpox, scarlet fever, and yellow fever, confer a considerable degree of immunity through their first attack.

2. Some degree of resistance to the successful entrance of specific diseases is the rule in all healthy human beings. This resistance is of at least two kinds: (*a*) the resistance of an unbroken surface; (*b*) the resistance of the normal tissues and fluids of the body, including the destructive power of the blood-serum on the microscopic causes of diseases.

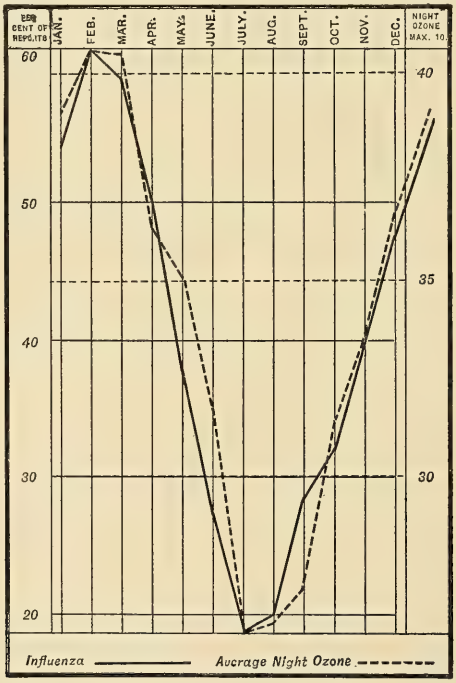
3. Atmospheric temperature and other conditions of the atmosphere have, to a great extent, controlling influence over the entrance of most of the specific diseases. This fact, although not generally understood

[1] Of all weekly reports received, the per cent. which stated that tonsillitis (or rheumatism) was under the observation of the physician reporting.

to be placed upon a scientific foundation, is popularly recognized. It is well known that diarrhœa is one of the "summer" complaints, and that coughs and colds occur most in cold weather. Recently the subject has been placed upon a scientific basis by reducing statements of facts relating to it to accurate statements of quantities—so much temperature or other meteorological conditions and so much sickness or so many deaths, as the case may be, from each important disease during a specified time. It has been found that most of the specific diseases sustain quantitative relations to atmospheric temperature, one class of diseases rising as the temperature rises, and another great class rising as the temperature falls. The changes in the sickness-rates and death-rates of some of the diseases lag behind the changes in the atmospheric conditions, just as they would be expected to do on account of the period of incubation and the duration of the disease. How closely

FIG. 62.

ATMOSPHERIC OZONE (NIGHT), AND SICKNESS FROM INFLUENZA, IN MICHIGAN. By months, for a period of twelve years (1877–88), the relation of *Sickness* in Michigan from *Influenza*[1] to the Average Atmospheric *Ozone* during *nights*.



some of the diseases conform to the atmospheric conditions is shown by Figs. 58–62.

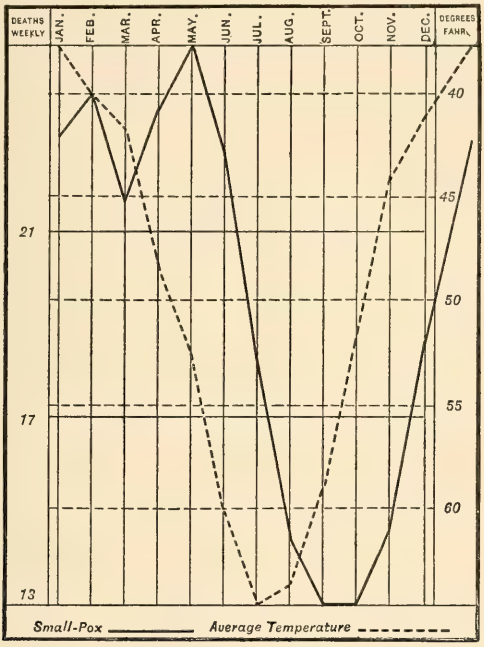
[1] Per cent. of reports which stated that influenza was under the observation of the physicians who made reports.

How it is that atmospheric conditions control to such an extent the entrance of specific diseases into the human body it is important should be understood, in order best to guard against their entrance. Probably the influences are complex, yet some of them seem to have been made apparent.[1] Simply lowering the temperature of the body is sufficient to cause some animals to contract a specific disease which otherwise is

FIG. 63.

TEMPERATURE, AND DEATHS FROM SMALLPOX, IN LONDON.

By months, for a period of thirty years (1845–74), the relation between the *Average Deaths from Smallpox* in London, England, and the *Average Atmospheric Temperature.* (The temperature curve is reversed; the scale increases downward.) Records of thirty thousand deaths are included in this diagram.



Except in a few months the smallpox changes follow two months after the temperature changes.

The line representing smallpox should follow as long a time later than a line representing its controlling condition as is the average duration of the fatal cases plus the period of incubation.

not contracted; thus Pasteur caused fowls to contract anthrax by causing the fowls, inoculated with anthrax, to stand in cold water. It is quite possible that raising the body temperature may be conducive to the contraction of some disease; but, as a rule, the warm-weather diseases seem to be due more to influences or absence of influences on the specific cause of the disease outside the body; thus it is alleged that the cause of yellow fever is destroyed by a "killing" frost.

[1] The writer has dealt with some of them in "The Causation of the Cold-Weather Diseases," *Annual Report Michigan State Board of Health,* 1887.

It should be generally known that, as a rule, all inflammatory diseases of the throat, air-passages, and lungs are increased by exposure to a cold atmosphere. The same is true of all specific diseases which generally enter the body by way of the throat, air-passages, or lungs (Figs. 58–63). On the contrary, diseases which generally enter the body by way of the mouth and alimentary canal increase during or following exposure in a warm atmosphere.

The Scientific Bases for Practical Sanitation.

Mortality Statistics.—Mortality statistics have supplied important bases for practical sanitation in several directions, one or two of which have already been suggested. The history of the prevention of smallpox through vaccination supplies one striking illustration. In the early years of vaccination the statistics included comparatively few instances of mortality influenced by this measure; yet even then the very great difference in the death-rates among vaccinated and unvaccinated persons was, to many physicians, conclusive evidence of the great value of vaccination as a sanitary measure. As time has passed the amount and strength of the evidence in this direction have been increasing, until now it cannot be doubted by any person of sound mind and ordinarily good reasoning powers who will carefully go over the evidence. Whoever wishes to investigate the subject thoroughly should have access to such evidence as that contained in "General Board of Health," *Papers relating to the History and Practice of Vaccination*, presented to both Houses of Parliament, and published in 1857; *Public-Health Reports*, John Simon, vol. i., published in London in 1887; and the *Report of the Royal Commission* on this subject, published in London in 1890. Vaccination began in England about the beginning of the present century. An idea of the immense importance of the subject may be gained by a simple statement of the statistics of the mortality-rate from smallpox in England at the close of the last century, and, by periods of years, since that time.

The average numbers of deaths from smallpox per annum, per million population, in England, at five periods of time, were as follows:

At the close of the eighteenth century	3000[1]
From 1841 to 1853	304
From 1854 to 1863 (compulsory vaccination since 1853)	171
From 1864 to 1877	251
From 1878 to 1887	54

In Sweden the average numbers of deaths from smallpox per annum, per million inhabitants, were—Before the introduction of

[1] Averages in the city of London were (Simon, *Public-Health Reports*, vol. i. p. 255): from 1681 to 1690, 3139; from 1746 to 1755, 3044.

vaccination (1774–1801), 1973; during the period of optional vaccination (1802–16), 479; during the period of obligatory vaccination (1817–77), 189.

Such vital statistics need to be supplemented by statistics of mortality in recent times among the vaccinated and among unvaccinated persons, in order to make it certain that the very great reduction in the mortality from smallpox is not a result of sanitary measures other than vaccination. Such statistics it is quite practicable to obtain at hospitals where smallpox is treated. A study of such statistics of cases wherever and whenever recorded seems to show that smallpox when not modified by vaccination is still the same deadly disease that it was previous to this nineteenth century. (Tables A and C illustrate this, and also the fact that the amount of vaccination counts for much. These two tables are copied from the *First Report of the Royal Commission on Vaccination*, London, England, 1889, pp. 116 and 117. In Table C the columns have been rearranged.)

On the other hand, Dr. Marson, during forty-two years of duty as physician of the London Smallpox Hospital, has never observed a single case of smallpox in the officers and employés of the hospital, who are revaccinated when they enter the service, and who are constantly exposed to the infection.

TABLE A.

Statistical Evidence of the Different Degrees in which Persons Vaccinated in Different Ways will be Safe against Death by Smallpox if they should afterward Contract this Disease.

The table is founded (*a*) on information given in the 36th volume of the Medico-Chirurgical Society's *Transactions*, by Mr. Marson, surgeon of the Smallpox Hospital, as the result of his observations made during sixteen years, 1836–51, in 3094 cases of post-vaccinal smallpox; (*b*) on data derived from Mr. Marson's evidence before the Vaccination Committee of 1871, based on a further experience of 10,661 such cases, and covering also sixteen years, 1852–67.

Cases of Smallpox classified according to the Vaccination Marks borne by each Patient respectively.	Percentage of Deaths in each Class respectively; uncorrected.[1]		Percentage of Deaths in each Class respectively; corrected.[1]	
	1836–51.	1852–67.	1836–51.	1852–67.
1. Stated to have been vaccinated, but having no cicatrix	25.5	40.3	21.7	39.4
2. Having one vaccine cicatrix . .	9.2	14.8	7.6	13.8
3. Having two vaccine cicatrices .	6.0	8.7	4.3	7.7
4. Having three vaccine cicatrices .	3.6	3.7	1.8	3.0
5. Having four or more vaccine cicatrices	1.1	1.9	0.7	0.9
Unvaccinated	37.5	35.7	35.5	34.9

[1] The terms "uncorrected" and "corrected" are used to signify the inclusion or exclusion of those fatal cases of smallpox in which the patient suffered from some other disease superadded to the smallpox.

TABLE B.

Analysis of Dr. Gayton's 10,403 *Smallpox Cases, issued in* 1885. *Fatality per cent. of Attacks.*

At Ages.	Not Vaccinated.	Vaccination Nominal.[1]	1 Scar.		2 or 3 Scars.		4 or more Scars.		Total Good.	Total Imperfect.
			Good.	Imperfect.	Good.	Imperfect.	Good.	Imperfect.		
0–05	56.5	39.8	0.0	17.0	0.0	11.1	0.0	6.6	0.0	11.5
5–10	35.2	19.3	2.5	7.4	1.0	5.5	0.0	1.5	0.9	5.0
10–15	23.3	19.6	1.9	5.8	1.1	3.1	0.0	1.0	1.1	3.4
15–20	42.1	19.0	2.3	8.9	2.1	6.4	0.9	1.2	1.9	6.3
20–30	49.8	32.1	4.8	18.0	2.8	11.5	6.7	7.0	3.9	13.1
30–40	40.7	35.7	8.1	18.8	13.5	13.0	0.0	1.9	9.5	14.8
40–	43.0	33.5	1.4	19.6	13.0	18.7	0.0	1.8	12.5	19.1

Compulsory Vaccination.—The mortality statistics in England, in Sweden, and elsewhere prove that since compulsory vaccination was enforced the mortality from smallpox has been less than before. (Table C, relative to England and Wales, illustrates this statement.) This is particularly true where compulsory measures can best be enforced, as, for instance, in armies; and where revaccination is enforced prevention seems to be complete. Thus, in the Bavarian army, where revaccination was compulsory, there was not a single death from smallpox nor a case of unmodified smallpox from 1843 to 1857.

TABLE C.

Mean Annual Deaths from Smallpox [*in England and Wales*] *at successive Life-periods, per Million living at such Life-period, 1847–53, 1854–71, and 1872–87.*

Period.	All Ages.	0–5.	5–10.	10–15.	15–25.	25–45.	45 and Upward.
(1) Vaccination optional, 1847–53[2]	305	1617	337	94	109	66	22
(2) Vaccination obligatory, but not efficiently enforced, 1854–71	223	817	243	88	163	131	52
(3) Vaccination obligatory, but more efficiently enforced by vaccination officers, 1872–87	114	242	120	69	122	107	47

From the foregoing it must not be inferred that compulsory vaccination and compulsory revaccination are the best sanitary measures in all countries and at all times. It is certainly proved that vaccination and revaccination are the most important measures for the prevention of smallpox, and that in an army it is possible to obtain excellent

[1] "Nominal"—said to have been vaccinated, but no marks visible.

[2] In this table the period of optional vaccination begins with 1847, not with 1838, because the deaths were not abstracted in combination with ages until 1847.

[Table C is from page 114 of the *First Report of the Royal Commission appointed to Inquire into the Subject of Vaccination*, London, England, 1889.]

results through compulsory vaccination and revaccination; but the question whether the law should or should not require compulsory vaccination in the United States is still an open one. Some of the bases upon which a conclusion should rest may be indicated here.

Statistics of mortality from smallpox, such as those just mentioned, relative to England and Sweden before and since compulsory vaccination has been required by law, should be compared with statistics of mortality from smallpox in other countries where compulsory vaccination has not been required by law. Such statistics have not yet been much studied. As an example, but not as conclusive, the following table is taken from an article on this subject in the *Transactions of the Michigan State Medical Society*:[1]

TABLE D.

Exhibiting, for the Nineteen Years, and for each of the Nineteen Years, 1869–87, the Number of Reported Deaths from Smallpox per Million of Inhabitants in Michigan,[2] in Comparison with the same for England.[3]

Years.	England.	Michigan.	Years.	England.	Michigan.
1869	67	37	1881	[4]119	50
1870	113	8	1882	50	[4]57
1871	[4]1012	60	1883	36	3
1872	821	[4]240	1884	82	2
1873[5]	98	69	1885	[4]103	2
1874	88	13	1886	10	[4]3
1875	35	19	1887	18	0
1876	99	53			
1877	[4]173	[4]69	Av. 1869–87	160.2	36.6
1878	74	4	" 1869–77	278.4	63.1
1879	21	4	" 1878–87	53.8	12.7
1880	25	2			

In England they have had compulsory vaccination since 1853. In Michigan vaccination depends upon the enlightened self-interest of the people. It may be seen that the reported mortality from smallpox is about four times as great in England as it is in Michigan. This might be due to one cause or to several causes; for instance, it is possible that a larger proportion of the deaths from smallpox that occur are reported in England than in Michigan.

It may be a long time before we have a scientific basis for such action as compulsory vaccination, especially among a people who govern themselves. It is likely to be still longer before we shall have a scientific basis for a law for compulsory revaccination.

[1] 1890, p. 159.

[2] Compiled from the Vital Statistics of Michigan.

[3] Taken from the Fiftieth Annual Report of the Registrar-General of Births, Deaths, and Marriages in England (1887), London, 1888.

[4] Crest of an epidemic wave.

[5] The Michigan State Board of Health was established in 1873.

While waiting for statistical proof of the wisdom of compulsory vaccination in countries governed by the people, the subject would seem to be one which should be discussed by those skilled in social science.

Compulsory Vaccination of Children and Adults.—Sir John Simon, C. B., F. R. S., who for many years was a leader in public-health work in England, has stated the principle involved in the compulsory vaccination of children to be the counting of vaccination "among those conditions necessary for the maintenance of life which a parent should not be entitled to withhold (any more than food or clothing) from his offspring."[1] He said, however, that if, before the passage of the law for compulsory vaccination in England, he had had occasion to express an opinion on the subject, he would have feared the operation of such a measure. "Believing that vaccination is beyond all comparison the greatest practical good with which medical science has enriched us, I should have felt the utmost apprehension lest by association with penal provisions it might perhaps become unpopular; lest this apparently unnatural combination should excite resistance or suspicion; lest the public should in any degree mistrust a gift which the law would compel them to accept."[2] Soon after the passage of the law he attributed its apparent success partly to the "English habit of respecting every actual law."[3] The habit of a people of a country, their mode of thought, should undoubtedly be considered in coming to a conclusion as to whether general compulsory vaccination is the best measure to secure general vaccination.

Compulsory vaccination or revaccination of adults cannot be urged on the same principle as can the primary vaccination of children. There the question relates not to a child without discretion, but to the person of a responsible individual. "It relates chiefly to the protection of his own person, because if the public have such faith in vaccination or revaccination as to require it of him, the public itself can act on that faith, and each of its members can voluntarily be vaccinated and revaccinated, and thus be protected even if the individual who objects to vaccination shall contract the smallpox. The risk is chiefly, if not entirely, to the person himself, and not to the public (if vaccination and revaccination are as effective as we believe); therefore it is a question if every responsible individual should not be allowed to act upon his own best judgment as to what virus, if any, he will have inserted in his own person.

"Compulsory vaccination of an intelligent adult person is such an interference with the liberty of the individual relative to his own

[1] *Public-Health Reports*, John Simon, edited by Edward Seaton, vol. i. p. 281, London, Eng., 1887.

[2] *Ibid.*, vol. i. p. 282.

[3] *Ibid.*, vol. i. p. 283.

person as, in my judgment, is not for the public good. I think the final result will be better if the natural risk of the death-penalty by smallpox be permitted to each responsible person."[1]

However, it sometimes occurs that the "greatest good to the greatest number" seems to require that all persons who have been very recently exposed to smallpox shall either be vaccinated or revaccinated, as the case may be, or that they shall be completely isolated from the public until such time as danger of their having or spreading the disease is passed. In such cases it would seem best to advise vaccination and to require one or the other alternative. The health officer of one great city in the United States[2] has, however, under such circumstances, permitted persons so exposed to go about under limited surveillance, they reporting to his office at stated times. This action was based upon the belief that smallpox is not communicated by the patient during the early stages of the disease.

As an illustration of an alternative measure to compulsory vaccination the experience in New York City is instructive: "In the spring and fall vaccinators are employed for temporary service, in addition to the regular vaccinating corps. The city is then divided into a number of districts. A vaccinator is placed in each, who visits every house and vaccinates all infants over three months of age whose parents desire it. In this way about thirty thousand children are vaccinated annually. Adults who request it are also vaccinated. The operation is performed upon from eighty to ninety thousand persons every year."[3]

As to the results of this method Dr. Edson says: "The vaccinating corps of the health department was organized in 1874. The result of its work was not apparent until 1876. The deaths from smallpox previous to 1876 averaged 59.57 per 100,000 per year; since 1876 they have averaged 8.38 per 100,000 per year, and this average is yearly being reduced. During the past sixteen months we have had only two cases of the disease in New York City. One of these cases occurred in the most thickly-populated part of the city, where the number of inhabitants per acre is greater than on any other spot in the world, yet so well was the neighborhood protected that not a single case occurred among the many persons that were exposed."[4]

The foregoing fact illustrates how smallpox may be prevented in a city. How a State can act for the prevention of smallpox is illustrated by the experience in Michigan, where previous to the establishment of a State board of health smallpox was an important cause of mortality. Soon after its establishment the State Board of Health published and

[1] *Trans. Mich. Med. Soc.*, 1890.

[2] Dr. O. W. Wight, then health officer of Detroit, Michigan.

[3] Dr. Edson, in the *Forum*, June, 1890, p. 480.

[4] *Forum*, June, 1890, p. 480.

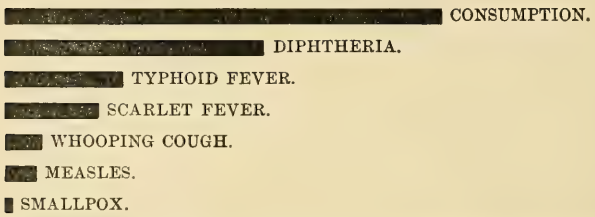
distributed widely throughout the State a pamphlet containing brief but plain directions how to restrict and how to prevent smallpox through vaccination and revaccination. Attention was called to a State law which authorizes the board of health of each city, village, and township at any time to direct its health physician to offer vacccination, with bovine virus, to every child not previously vaccinated, and to all other persons who have not been vaccinated within the preceding five years, without cost to the person vaccinated, but at the expense of the city, village, or township as the case may be.

From time to time the State Board of Health in Michigan called the attention of the numerous local health officers, and called public attention, to the importance of vaccination; and such efforts were at times very successful, because of the fact of the occurrence of cases of smallpox. Printed leaflets setting forth reasons why "this is a good time to be vaccinated" have done much to call attention of the people to the subject.

How effective have been such measures as are employed for the prevention of smallpox may be appreciated by a study of a diagram exhibiting the present place of smallpox among diseases in Michigan, and remembering that before the time of vaccination, previous to this century, smallpox was one of the diseases which caused most deaths.

FIG. 64.

Deaths in Michigan, 1876–87.



This diagram is accurately drawn to a scale, and the *relative importance* of each disease, as a cause of deaths in Michigan, is therefore correctly shown.

The Michigan State Board of Health was established in 1873. A comparison of the deaths from smallpox reported to the Secretary of State as having occurred in Michigan during the five years (1869–73) preceding the organization of the State Board of Health, with the fourteen years (1874–87) since the State Board of Health was established, and making corrections for increase of population, proves that the death-rate from smallpox in Michigan has been reduced 6.62 persons per year per 100,000 inhabitants, and that 1554 persons who, according to the death-rate previous to the establishment of the State Board of Health, would have died of smallpox, have not died—their lives have been saved. One thousand five hundred lives saved from smallpox

means a saving also of at least six thousand cases of sickness from that loathsome disease.

Typhoid Fever, as Influenced by Water-supply and Sewerage.—The recorded instances of the prevention of typhoid fever through improved sanitary conditions, notably improved water-supplies and improved systems of disposal of human excreta, supply an important basis for practical sanitation, because it seems fair to assume that what man has done man may do in this direction.

One of the most complete and reliable summaries of the evidence on this subject that has ever been published is in an article entitled "The Influence of Sewerage and Water-supply on the Death-rate in Cities," by Irwin F. Smith (now of the U. S. Department of Agriculture), published by the Michigan State board of health in the Proceedings of the Sanitary Convention held at Ypsilanti in 1885. From that and other sources a few of the most striking instances are here mentioned.

The city of Munich, Bavaria, is the home of the eminent scientist and sanitarian, Professor Max von Pettenkofer. For many years he has devoted much time and labor to the subject of the causation and prevention of typhoid fever. It is therefore probably more than a coincidence that in that city there has been the most remarkable evidence of the lessening of typhoid fever that has ever been recorded. Previous to 1859 there were no sewers or regulations for keeping the soil of the city clean; the water-supply was from wells; the citizens avoided the well-water when possible, and strangers were warned not to use it; the mortality from typhoid fever was 24.20 per 10,000 inhabitants. In 1860 to 1865 reforms were begun by cementing the sides and bottoms of porous vaults and cess-pits; the mortality from typhoid was then 16.80. During the years 1866 to 1873 there was partial sewerage; the mortality from typhoid fever was 13.30. During 1874 to 1880 sewerage was continued; the mortality from typhoid fell to 9.26. During 1881 to 1884 sewerage was still further continued, and the mortality from typhoid fell to 1.75 per 10,000 inhabitants.[1] Since that time it has been claimed that typhoid fever has practically disappeared from Munich—that there are no cases of the disease contracted in the city, the only cases seen being those that come there after having contracted the disease outside that city.

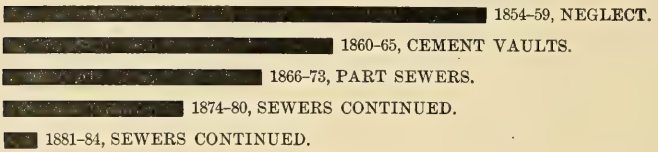
This would seem to prove that it is possible to prevent typhoid fever entirely. It seems to prove what are the essential measures for the accomplishment of that very desirable result. However, it is important to hold in mind at least one fact which in the foregoing brief summary has not received proper notice: that fact is that coincidently

[1] The lessening of typhoid in Munich is graphically exhibited in the diagram (Fig. 65) on page 164.

with the improvements in the methods of disposal of excreta, which are mentioned as having occurred in Munich, there were improvements in the water-supply other than those which are implied as having occurred through the securing of a cleaner soil underneath the city, because there was a progressive change from a water-supply derived from numerous local wells to general water-supplies from springs and other sources without the city.

FIG. 65.

Typhoid Fever and Sewers in Munich.



One who believes, with Pettenkofer, that the purifying of the soil is the principal element in the lessening of typhoid fever, may be inclined to disregard the fact of the coincident improvement of the water-supply in Munich as a factor in lessening the fever in that city; and, on the other hand, one who believes that typhoid fever is usually spread by means of the water-supply may be inclined to disregard the evidence relative to the disposal of excreta, except as that influenced the condition of the water-supply; yet in the present state of our knowledge of the subject it seems best in this instance to hold fast to the combined evidence as it stands, because, although to the writer it seems probable that the way in which typhoid fever is most commonly spread is through contaminated water used for drinking and other purposes, yet the possibility of its being spread in other ways, including that by dust from human excreta, remains for further investigation.

The mortality statistics in New Orleans, in connection with the facts relative to the lack of sewerage and the source of the water-supply in that city, seem to bear upon the question whether water-supply or sewerage has most influence on the death-rate from typhoid fever. In New Orleans there has been a general lack of sewerage; the water has been in great part rain-water derived from the roofs of buildings, where it would not be liable to as much contamination by excreta as would be water in wells: the death-rate from typhoid fever has been comparatively low, about as low as in New York, in which city there is both sewerage and a general water-supply.

Tabulated Records of Experience.—Probably the most important and most reliable basis for practical sanitation is that supplied by records of actual experiences in sanitation, collated, classified, tabulated, and so arranged as to give positive answers to definite questions con-

cerning results of certain measures. Some of the most valuable of such experiences have resulted from a belief in the germ theory of disease, and that theory has, in turn, received strong support from the experience.

Theories relative to disinfection also, based upon laboratory experiments, have contributed toward practices in sanitation: these experiences in turn have yielded positive knowledge of disinfection, as it has been thus applied, which is of great practical importance. Thus it has now been demonstrated, by the tabulated experiences in Michigan during a series of years, that isolation and disinfection are effective measures for the restriction of diphtheria and of scarlet fever. This seems to prove two things: (1) that these diseases are communicable; and (2) that the method of disinfection adopted is effective. As examples of the evidence on this subject two diagrams are here submitted, one exhibiting the results of experience with diphtheria (Fig. 66), and one with scarlet fever (Fig. 67). Each diagram relates to a single year, and

FIG. 66.

ISOLATION AND DISINFECTION RESTRICT DIPHTHERIA.

Diphtheria in Michigan in 1888.—Exhibiting the average number of cases and deaths *per outbreak:* in those outbreaks in which Isolation and Disinfection were both *Neglected*, and in those outbreaks in which both were *Enforced.* (Compiled in the office of the Secretary of the State Board of Health from reports made by local health officers.)

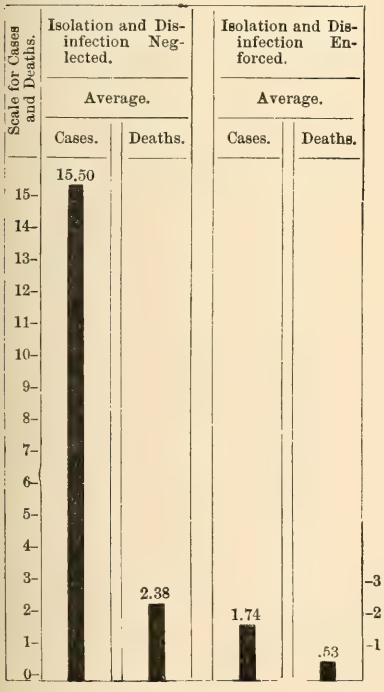
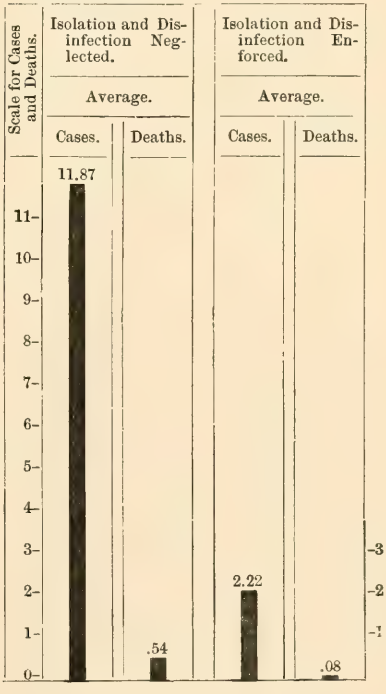


FIG. 67.

ISOLATION AND DISINFECTION RESTRICT SCARLET FEVER.

Scarlet Fever in Michigan in 1888.—Exhibiting the average number of cases and deaths *per outbreak:* in those outbreaks in which Isolation and Disinfection were both *Neglected*, and in those outbreaks in which both were *Enforced.* (Compiled in the office of the Secretary of the State Board of Health from reports made by local health officers.)



the experience proves that in those outbreaks in which isolation and disinfection were neglected there were several times as many cases and deaths as there were in those outbreaks in which isolation and disinfection were enforced.

The facts have been collected and compiled in Michigan for other years, and the general fact seems to be established that in townships and small cities and villages about four-fifths of the cases and deaths from scarlet fever, and about the same proportion of the cases and deaths from diphtheria, are prevented in those localities in which the first case or cases that occur are promptly isolated, and after death or recovery thorough disinfection is enforced. This statement relates only to those localities in which at least one case has already occurred; of course the danger of the disease spreading to other localities, and thus starting new outbreaks, is greatly lessened in those localities where prompt restrictive measures are enforced; therefore it is below the truth to say that in townships and small cities and villages four-fifths of the cases and deaths from scarlet fever and diphtheria are known to be prevented by isolation and disinfection.

This is a very important fact concerning both of these diseases, and is especially important relative to diphtheria, because in many parts of the country the people and the medical profession have been loath to believe that diphtheria was a communicable disease, and that it could be to such an extent prevented. It is important information on which to act, because in many parts of this country diphtheria is one of the diseases which causes most deaths, and scarlet fever also is a very important cause of death in the northern portions of this country.

A Few of the Functions of State Boards of Health.

Such information as that exhibited in the two diagrams, "Isolation and Disinfection restrict Diphtheria," and "Isolation and Disinfection restrict Scarlet Fever," could only be obtained in one way—namely, by collecting and compiling the facts concerning the experiences with those diseases under the different managements of local health authorities. This illustrates one of the most important functions of State boards of health—the collection, digestion, tabulation, and graphic representation of the experiences in different localities, and especially under differing conditions, with the view of learning what conditions it is important to maintain.

Another important function of State boards of health is the dissemination of such information to the people, to the medical profession, and especially to the local health authorities. To this last class of persons it is important especially, because of the fact that such local officers are subject to change, and a considerable proportion of them do

change each year, with the result that many of the local officers are entirely new to their official duties. By means of circulars of information, a State board of health can place before all local health officers such useful general facts as result from the collection and elaboration of the reported experiences under the jurisdiction of the several local officers. The State board can do more than that, because through its system of exchanges it receives the results of work on similar though not identical subjects which is done throughout the United States and throughout the world.

Thus through the proper services of a State board of health it is possible for each local health officer who is in close sympathy and correspondence with it to bring to bear upon any question of local sanitation the best knowledge on the subject in his own country or abroad.

Conversely, through reports to the State board of health it is possible for every local health officer to contribute valuable data which will be useful not only to his fellow health officers and citizens in his own State, but also to humanity throughout the civilized world.

Perhaps the most important function of a State board of health is that whereby, through the distribution of leaflets of instruction to the neighbors of infected premises, it is possible to gain the coöperation of the people with the local health officer for the restriction of the dangerous communicable diseases, without which coöperation such diseases cannot be restricted.

At the meeting of the Sanitary Institute of Great Britain in 1890 the Hon. F. A. R. Russell, with reference to the utility of a State board of health, said: "The fact is, infectious disease is not merely local, and cannot be dealt with effectually by local authorities, because if one is active another is negligent, and because such separate and uninformed authorities cannot attack the enemy with anything like the force or precision of a trained brigade. There is no escape from the urgent need of State control in respect of epidemic and spreading diseases, for a single neglected district is a danger to the whole nation."

National Health Service.

As the State board of health collects from each local board the results of its experience, and disseminates to every local board in its State the knowledge gained from the combined experiences, so the national board or other national health service should glean from the work of State, municipal, and other local boards of health whatever promises to be useful, and should combine with such facts mortality and morbidity statistics, meteorological, climatological, and other data, and results of laboratory investigations, with the view to the building up of sanitary science upon foundations of truth. Each State board of health should receive from the national board of health the results of

the useful experiences of all State boards, and such information as the national board is able to obtain from foreign governments or from its own consuls, ministers, or agents in foreign countries. Economy in labor requires that the National Government shall do for the several States what otherwise each State must do for itself, and thus save repeating many times the labor which should be done only once, but most thoroughly and completely, by one central office of the General Government.

There has been much quibbling and hair-splitting discussion as to whether the United States Congress has power to provide a national health service. But manifestly such a service is essential to the public welfare, and by the Constitution "Congress shall have power . . . . to provide for the common defence and general welfare of the United States." In fact, one of the purposes of the Constitution, as declared in the preamble, is to "promote the general welfare" of the "people of the United States," "ourselves and our posterity." Congress has established a national Department of Agriculture in order to "promote the general welfare" by fostering one of the most important industries in this country. This especially fosters the interests of a class of citizens, because of the exceeding importance of the labors of that class to the whole people of the United States. A national health service, however, would conserve the highest interests of every citizen, the interests of life itself, and would be far above any other interests of any class of citizens. Surely there should be no question as to the power and duty of Congress to provide a national health service.

As to what should be the nature of the national health service, some of the reasons previously mentioned for the existence of a State board of health apply with equal force for the existence of a national board of health. However, even greater stability and permanence could be provided for in other ways. Recent expressions of opinion are here mentioned.

At the International Medical Congress in Berlin in 1890, Dr. A. L. Gihon, Medical Director of the United States Navy, offered a resolution as follows: "*Resolved.* That it is the opinion of the Tenth International Medical Congress that there should be in every country an executive department of health, under the direction of a Cabinet minister, charged with the sanitary interests of the nation, the collection of its vital statistics, and the observations of the demographic effects of climate, occupation, and social conditions." [1]

At the meeting of the American Medical Association, in Washington, May 5, 1891, a resolution, reported by a committee, was adopted, as follows: "*Resolved,* That the president of this association appoint a committee of five to memorialize Congress at its next session on the

[1] *Report of the Surgeon-General U. S. Navy,* 1890, p. 28.

subject of creating a Cabinet officer to be known as the Medical Secretary of Public Health."[1]

Among the reasons for the establishment of a national health service the committee of the American Medical Association close as follows: "Finally, the unification of all things relating to public hygiene in the States through the aid of State boards of public health will give a solidity and usefulness to the practice of medicine never hitherto attained."[2]

In the "Address on State Medicine" at the last meeting of the American Medical Association, Dr. W. L. Schenck, professor of State Medicine and of Pathology in the Kansas Medical College, expressed himself on this subject as follows: "The enlightened statesman knows that the strength of a nation lies in the strength of its people, and that the highest function of law is the protection of their life, health, and development—that 'public health is public wealth.' When he comprehends that the great epidemics that destroy mankind, causing untold suffering and immeasurable financial loss, are amenable to State medicine, may we not believe that the National Government will establish *a department of public health*, under whose protecting ægis it will gather the Marine Hospital service, the Bureau of Education, of Vital Statistics, and of Animal Diseases, the Climatological and Signal Service, all that pertains to the health and development of the people; providing that, as in the army and navy, its appointments shall be preceded by thorough examination and be made for life? In such a department there would be enrolled a body of scientists unequalled in the world, working in harmony for the highest interests of mankind—the prevention of disease, the preservation of life, and the uplifting of humanity, giving dignity to State medicine, and the highest possible physical, intellectual, and moral development to the nation."[3]

Outline of the Leading Principles Applicable for the Prevention of the most Important Diseases.

It should be distinctly understood that the prevention of a disease generally requires the fulfilment of more than one measure. Usually there are several factors contributing to the causation of a disease, and many things can be done by individuals, by communities, and by governments to lessen the probabilities of persons contracting a dangerous communicable disease. However, there is usually some one dominant fact which it is pre-eminently important to consider in the prevention of disease.

Thus, for the restriction and prevention of consumption and other tubercular diseases probably the most important of all measures is the destruction or disinfection of all sputa of consumptive persons.

[1] *Journ. Amer. Med. Assoc.*, May 16, 1891, p. 719. [2] *Ibid.* [3] *Ibid.*, May 23, 1891, p. 733.

For the restriction and prevention of pneumonia it is probable that a similar measure is important.

For the restriction and prevention of typhoid fever the most important measures are those which tend to prevent the taking into the bodies of persons, especially with the drinking-water, substances derived from or contaminated by human excreta. Much can be done by individuals, but more by governments, through provisions for sewerage and for public water-supplies of known purity. In military and other camps, where primitive methods of disposal of excreta are permitted, flies as carriers of infection must be considered.

For the restriction and prevention of diphtheria the prompt and continued isolation of all infected persons and things, and their thorough disinfection before they are released from isolation, are the important measures. For the restriction and prevention of scarlet fever the same measures are applicable.

For the prevention of intermittent fever the most important measure has been believed to be the lowering of the subsoil water; but investigations have shown that the lessening of areas of stagnant waters on the surface has been of much greater importance, by lessening the places where mosquitoes were bred. The general introduction and use of screens in windows has probably been a useful measure for the lessening of the spread of intermittent fevers by means of mosquitoes. In some of the States public lands have been given by the government for the purposes of drainage of swamp-lands, and through such general measures of drainage malarial diseases have been very greatly lessened. This has been the case in Michigan, in which State the sickness statistics show that the sickness from intermittent fever decreased during the ten years ending with 1897 by nearly two-thirds.

Some of the most important diseases have now been mentioned, but the exceeding importance of the one which causes most mortality warrants its treatment a little more in detail.

The Restriction and Prevention of the Tubercular Diseases.—For this the most important measures are—

(*a*) *The Destruction or Disinfection of all Sputa of all Consumptive Persons.*—If this could be completely accomplished, it would probably go far toward the entire prevention of the disease known as consumption, and also the other tubercular diseases. But as this can hardly be expected during the lifetime of the present generation, other measures, tending to lessen the danger of contracting the disease are important.

The destruction of the sputa, however, is so important that extraordinary effort should be made to spread among all classes of people such knowledge of the causation of tubercular diseases as will tend to make the people willing to conform to measures for the destruction of all infected sputa. The fact should be impressed upon all that animals

not infrequently contract tubercular disease from the sputa of man—that a phthisical herdsman might thus scatter tubercular disease through a herd of cows, the milk and meat of which might spread the specific cause of tubercular disease throughout a town. Inventive talent might well be employed in devising convenient, practicable methods of destroying all sputa. Portable spit-cups of paper, held in a metallic frame, the cup and contents to be removed and burned, have been devised and sold. A pocket-flask (Dettweiler's, or Knopf's), to contain a disinfectant and to receive the sputa, is also on sale. I have recommended that a paraffined or otherwise prepared paper be sold, in pieces of convenient size and in packages somewhat as cigarette papers are sold, and that each sputum be received on such a paper, the ends carefully twisted, the whole then enclosed in another piece of the paper, and the ends of that twisted, the package to be burned at the first convenient opportunity.

(*b*) *Measures for Lessening the Liability of Inhaling the Dust of Rooms occupied, permanently or temporarily, by a Consumptive Person, especially Public-Assembly Rooms, the Air in which is Liable to Contain the Dust from Dried Sputa of Consumptive Persons.*—One of these measures is the providing, in convenient places, of cuspidors containing a strong disinfectant. One of the most important measures, however, relates to the ventilation of all occupied rooms, which should be so planned that the movement of the air in the room should be constantly downward and out at the floor-level. This reduces to a minimum the danger of the particulate cause of consumption rising from the floor or carpet on which it may have fallen with the sputa of a consumptive person. Such a constant downward movement of the air of the room implies a constant renewal of the air in the room by the entrance of fresh air from out of doors. It also implies that either as it enters it is warmer than the air of the room, and will therefore immediately rise to the upper part of the room, or that the fresh air is caused to enter the room near the ceiling. Such a system of ventilation as will secure a constant moderate movement of air downward and out at the floor-level will be a useful sanitary measure, aside from its importance and usefulness in lessening the danger of inhaling contagia of disease with the dust of the room ; but, as not only tubercular diseases but also other diseases are spread by infectious dust, this is one of the most important points to be considered in the ventilation of any room.

It is apparent that no individual can control, except to a limited extent, the ventilation of rooms into which he goes. All such measures for the common safety of life and health are proper subjects for action by individuals, by communities, and by governments, local, State, and national.

(*c*) So long as bovine animals used as human food have this disease to such an extent that in some localities as high as 4 per cent.

are affected, it is desirable that measures be taken to lessen its spread through the use of tubercular meat or milk. There should be meat inspection, and also inspection by expert veterinarians to detect the disease in animals giving milk or to be slaughtered for food. Milk not known to be free from the bacillus may be boiled. To prevent the disease from being spread to dairy cows and to other food animals, those persons who care for such animals should be free from consumption, or, if not, should employ extraordinary care to avoid contaminating the food, water, or air-supply of such animals with the infected sputa.

(*d*) The researches of Bowditch, Buchanan, Pepper, Trudeau, and others have proved that residence in low, cold, undrained, cellar-like places favors the occurrence of consumption. My own researches have proved that sickness and deaths from consumption increase after existence in a cold atmosphere, and decrease after existence in a warm atmosphere; also, that consumption follows the occurrence of pneumonia and of the inflammatory diseases of the throat and air-passages, and that these follow existence in a cold atmosphere (Figs. 60–62). The recent general movements of people whose greatest danger is in the lungs or air-passages to a warmer climate, at least during the colder months of the year, seem to be founded upon established facts, and many lives are thus prolonged.

(*e*) The tubercular diseases are wasting diseases, and there seem to be reasons for believing that an important factor in their prevention is the maintenance in perfection of the quality of the blood, especially of its albuminous constituents. Good food, and plenty of it, favors freedom from consumption.

(*f*) The importance of outdoor life for the prevention of consumption is generally accepted. How and why it is effective has not been much dwelt upon; but the increase of appetite for food consequent upon outdoor exposure is well known, as is also the fact that those oxidations of effete matters in the body which in persons who live indoors so frequently stop short of completion, and thus leave in the body irritating substances like uric acid, are more completely effected in persons who remain much in the outdoor air.

Theoretically, with our present knowledge consumption, which still is the most important cause of mortality, is now, next to smallpox, one of the most easily preventable diseases. The next quarter of a century should see it lessen in importance as a cause of deaths until it takes its place alongside of smallpox among diseases whose greatly lessened mortality has been brought about by special methods in general sanitation. Something of the importance of what this implies to mankind throughout the world may be inferred from a comparison of the present mortality-rates from consumption and smallpox. Such a comparison, for a representative State, is exhibited in Fig. 64.

NUTRITION AND FOODS, INCLUDING THE TREATMENT OF OBESITY AND LEANNESS.

By I. BURNEY YEO, M. D., F. R. C. P.

Food is needed to supply the body with the substances required for its growth and repair, and for the development of those modes of energy which are termed its functions. A perfect food for any living organism must comprise all the elements needed for the maintenance of its structure and the support of its functions. It is also an essential condition that these elements be supplied in such forms or in such states that the organs of the body can digest and assimilate them.

The various organic and inorganic compounds which enter into the composition of the human body may all be resolved into the following twelve elements: carbon, hydrogen, oxygen, nitrogen (these four in far greater proportions than the others), sulphur, phosphorus, chlorine, iodine, potassium, calcium, magnesium, and iron. A few other elements (such as fluorine, silicon, manganese, etc.) have been discovered in the human body, but it is doubtful if they are invariably or necessarily present.

All these twelve elements must be represented in the food of man, and they must be, for the most part, combined in the form of organic products capable of being appropriated by his digestive organs.

If we examine the chemical composition of those organic compounds prepared by the vegetable world, and which serve as food for animals, we find they consist chiefly of the following elements: carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus.

Of these elements nitrogen is the most important, as it is *the* essential element of all *living* things: vital phenomena, the activity and change characteristic of all *living* things, are found only where this element is present.

Alimentary Principles.[1]—As the result of the chemical analysis and investigation of the various substances commonly used as foods, it has been found possible and convenient to take certain *alimentary principles* found in them as a basis for the classification of foods into four great divisions, the members of each division possessing a remarkable

[1] For the arguments and facts on which the following conclusions are based the reader is referred to the author's work on *Food in Health and Disease.*

similarity in composition and differing greatly in physical and chemical characters from the members of the other groups.

These different groups also appear to serve more or less different purposes in nutrition, although to some extent the members of one group may replace those of another. A combination of all four classes appears to be necessary for the maintenance of the animal body in perfect health.

These groups of alimentary principles are here exhibited in a tabular form:

Alimentary Principles.

1. *Albuminates*—Nitrogenous substances, having the same or nearly the same chemical composition as Albumin. *Examples*: Albumin, Fibrin, Syntonin, Myosin, Globulin, Casein, from the *animal;* Glutin and Legumin, from the *vegetable* kingdom.

(*a*) *Subordinate* nitrogenous substances referred to this class, and known as—

Gelatigenous substances { Gelatin, Chondrin.

2. *Fats* or *Hydrocarbons*, containing Carbon, Hydrogen, and Oxygen—the proportion of oxygen being insufficient to convert all the hydrogen into water. *Examples*: Olein, Stearin, Margarin (Butter is a familiar one).

3. *Carbohydrates* contain Carbon, Hydrogen, and Oxygen, the two latter elements in the proportions to form water. *Examples*: Starch, Dextrin, Cane-sugar, Grape-sugar, and Lactose or Milk-sugar.

(*a*) The *Vegetable Acids*, Oxalic, Tartaric, Citric, Malic, Acetic, and Lactic, are by some authors referred to this class.

4. *Mineral.*

Salts.—Sodium and Potassium Chlorides, Calcium and Magnesium, Phosphates, Iron, etc. etc.

Water.

In addition, however, to these four groups may be mentioned the various substances termed *food-accessories*, comprising the several condiments which give flavor to food or stimulate the digestive secretions, and the well-known "stimulants," tea, coffee, cocoa, alcohol, etc.

The uses and purposes of these different classes of alimentary substances may now be briefly stated:

(1) The functions of the class of albuminates is no doubt threefold:

(*a*) They contribute to the formation and repair of the tissues and fluids of the body, and in an especial manner to that of the nitrogenous tissues.

(*b*) They regulate the absorption and utilization of oxygen, and so play a very important part in the chemistry of nutrition.

(*c*) Under special conditions they may also contribute to the formation of fat, and to the development of muscular and nervous energy, and to the production of heat. They are capable of splitting up in the organism into a nitrogenous and a non-nitrogenous part, and from the latter fat may be formed and deposited in the tissues or consumed in the production of force.

With regard to the utility of the *gelatigenous* substances in nutrition, it has been determined that gelatin is useful as an "albumin-sparing" food, and that alimentary substances containing it tend to prevent the destruction of albuminates and fats. It is especially appropriate to those febrile states in which the stability of the "organic albumin" is threatened, and at the same time the capacity of assimilating albuminous food is greatly diminished.

(2) As to the uses of the *fats* and *hydrocarbons* in nutrition, one of the great purposes served by fat in the food is to diminish albuminous metabolism, and it is therefore regarded as an "albumin-sparing" food. "If flesh alone be given, large quantities are required in order that nutrition and waste may balance one another, but if fat be added the demand for flesh is less."—*Bauer*.

But the fats also have an important relation in the body to the production of force and heat, to body-work and body-temperature. While, unlike the albuminates, the metabolism of hydrocarbons is independent of the amount taken in as food, it is notably affected by bodily exercise, which produces little effect on nitrogenous metabolism. The fats, therefore, undoubtedly minister to force-production, and undergo destruction and oxidation in the process; so that the amount of carbonic acid given off during exercise is much greater than during rest.

It would appear that albuminates and fats are, to a certain extent, opposed to one another in their action on the organism, as the former increase waste and promote oxidation, while the latter have the effect of diminishing these changes, and this they do probably by affecting the metabolic activity of the cells of the tissues themselves.

A proper use of fat economizes the albuminous elements of food and checks the waste of the albuminous tissues. Fat enters into all the tissues. By its decomposition and oxidation it yields muscular force and heat, and it is therefore largely consumed in muscular exercise. By its capacity of being stored up in the body as adipose tissue it provides a reserve store of force-producing and heat-generating material which can be utilized as required.

(3) The *carbohydrates*, like the fats, check albuminous waste. They are ultimately resolved by combustion within the body, like the hydrocarbons, into carbonic acid and water, and so, like the fats, are capable of yielding heat and mechanical work. Unlike the fats and the albuminates, however, they do not appear to enter into the structure of the tissues, although they are found in some of the fluids and organs of the body.

All the carbohydrates are converted into glucose, or grape-sugar, before they are absorbed, and in this form they are much more readily metabolized than the fats or albuminates.

It is believed by many—and the weight of evidence is in favor of the

conclusion—that carbohydrates can be converted into fat within the organism. It is certain that they promote, either directly or indirectly, the separation of fat within the body, and by their capacity for rapid metabolism contribute largely to the production of heat and mechanical work, and, also, that their use greatly favors an increase in the constituents of the body, and especially of the albumin and fat. If we desire (according to Bauer) to increase the albumin without adding greatly to the store of fat, we should give a liberal allowance of albuminates with relatively small quantities of carbohydrates. But if we desire a substantial addition to the fat, the food should contain less albumin and more carbohydrates, with a fair proportion of fats.

(4) *Water and mineral substances* are of great importance, and are as essential to nutrition as the albuminates. There is no tissue that does not contain lime, chiefly in the form of phosphate, and it would seem that cell-growth cannot go on without it; indeed, calcium phosphate is the most abundant salt in the body, seeing that it forms more than one-half our bones. Calcium carbonate occurs in association with this phosphate, but relatively in much smaller quantity. Sodium chloride is also a very important salt which likewise occurs in all the tissues and fluids of the body. It plays a very important *rôle* in promoting the diffusion of fluids through membranes, and its presence is necessary for maintaining the globulins in solution. It is absolutely necessary to existence, and its *entire* withdrawal from food would be speedily fatal. The phosphates of sodium and potassium are also important salts. The alkaline reactions of the blood-plasma and some of the other fluids is due partly to these alkaline phosphates. Iron is an essential constituent of hæmoglobin, and therefore of the red blood-corpuscles; it is found, also, in striped muscle and in other tissues in minute quantity. These and other mineral substances are introduced into the body as constituent parts of the various ordinary articles of human food, animal and vegetable, with the exception of sodium chloride, which is usually added to various articles of food in greater or less amount, although they may themselves contain it.

Water enters into the composition, in greater or less proportion, of most solid and all fluid foods, and it is the essential basis of all beverages. It forms 58.5 per cent. of the human body, from which it is continually passing off by the kidneys, bowels, skin, and lungs. Water is essentially requisite in the process of digestion and absorption as a solvent for food-substances, and it is also required for the solution of the various materials which have to be removed from the body in the excretions, especially in the urine. Indeed, there is no vital action possible without water. The amount of water needed by the body depends on various circumstances, especially on bodily temperature and bodily labor. The greater the functional activity of the bodily organs,

the greater the need for water. The temperature and humidity of the surrounding air also exercise an influence in this direction, as well as the nature and amount of solid food.

It has now been seen that each of these four classes of alimentary substances has a special value in nutrition, and although the members of one group may be competent to serve, to a certain extent, the purposes of those of another, yet in order to accomplish the best results a combination of all of them is required. An adequate diet must contain a mixture of several articles of food, in which all these classes are represented in due proportion.

Food in Diseases of the Digestive Organs.

Acute Gastric Catarrh.—This is a common disease, and is caused usually by the action of improper and irritating food on the gastric mucous membrane. Any local irritant may, of course, excite inflammation of this membrane if brought in contact with it, and acute gastric catarrh is an almost invariable accompaniment of irritant poisoning; but the common and familiar forms of this disease are most frequently the result of improper feeding. Some persons are, however, much more predisposed to suffer from this disease, from comparatively slight causes, than others.

It has been pointed out that too scanty a secretion of gastric juice, by retarding digestion and favoring abnormal decomposition of food within the stomach, predisposes to this malady, and hence it is necessary in febrile states, when, owing to the high temperature, there is much loss of fluid from the skin and lungs, and therefore diminished secretion of gastric juice, to diminish accordingly the quantity of food. The common custom of urging such patients to take more nourishment than they wish is often injurious, unwise, and unphysiological.

Generally, anæmic and feeble persons and convalescents from acute disease are also liable to attacks of acute gastric catarrh from taking more food than the small amount, or the altered and less active character, of their gastric juice is capable of dealing with, so that some of the undissolved ingesta decompose and set up irritation of the gastric mucous membrane.

Overloading the stomach with food, even in healthy persons, is a common cause of acute gastric catarrh, owing to the abnormal decomposition which the excess of ingesta undergoes. This is a frequent cause of gastric catarrh in young children, and especially in children at the breast, who are allowed, for the sake of quiet, to suck until they overload their stomachs.

Imperfect mastication also may give rise to gastric catarrh, as the food then reaches the stomach in a comparatively undivided state, so

that the gastric juice comes in very imperfect contact with it, and hence portions remain undissolved and undergo decomposition. Rich and fat sauces and too much fat eaten with meat may lead to the same result, by covering or soaking the meat with an oily fluid which prevents the gastric juice from thoroughly penetrating it.

Food eaten when it is already in a state of decomposition may similarly give rise to gastric catarrh; and this is especially noticeable in delicate and sensitive persons. Game or fish kept too long, entrées made with meats that are not perfectly fresh, new beer and sour wine, and in young children milk that is not quite fresh, are fruitful sources of gastric catarrh.

Too free use of spices, stimulants, and condiments, and especially the habit of taking alcohol in a concentrated form, lead to the same result.

In *severe* cases of acute gastric catarrh the indication with respect to food is so to limit it in quantity and quality that the acutely inflamed mucous membrane shall be spared all irritation or excitement from ingesta, and the whole organ be, so far as is possible, put in a condition of physiological rest. Entire abstinence from food, at least from food taken by the mouth, may often be enforced with advantage for a day or two, or so long as the taking of food excites nausea or vomiting or severe pain. This abstinence is usually well borne, except in cases in which the strength has been exhausted by previous suffering and long inability to digest a sufficient quantity of food; in such cases nutrient enemata may for a time be given, so as to secure the rest needed by the hyperæmic and irritated gastric mucous membrane; while small quantities of iced water may from time to time be taken into the stomach.

When, however, there is a great craving as well as a real need for food, fluid nourishment only must be carefully administered. In the selection of such fluid foods it must be remembered that the gastric secretion is alkaline, from admixture with mucus; that its digestive power is therefore greatly impaired; and that there is a great tendency to abnormal decomposition of food in the stomach. Milk, if given undiluted, or eggs, or any food requiring acid gastric juice for digestion, may be found to disagree with the patient. In such cases we should dilute the milk with an equal quantity of soda- or lime-water, and in some instances admixture with the alkaline Vichy water is preferable, as it seems to check the tendency to curdling of the milk and the formation of an irritating coagulum in the stomach. In some instances, where there is an obvious inability to digest the casein of milk, *whey*, freshly prepared, should be substituted for milk; and its nutritive qualities may be increased either by the addition of a little beef-essence or by shaking up the yelk of an egg with a little hot water and adding this in suitable proportion to the whey.

It is most important that all food used in these cases should be quite fresh and freshly prepared.

The *beef-essence* referred to is best prepared by cutting the lean of beef into small pieces and placing it in a wide-mouthed bottle securely corked, and thus allowed to stand for several hours in a vessel of boiling water. This may be given in teaspoonful doses to infants who cannot take milk, and in larger quantities to adults.

When we restrict patients to liquid food it is best to give it in small quantities at short intervals, and when there is much thirst it is better to allow small pieces of ice to be sucked than to permit large draughts of cold water to be taken.

In many of the less severe cases, while still adhering to a fluid dietary, we may provide the patient with a certain variety of food. When milk is well borne, either pure or diluted, raw or boiled, it forms the most convenient and nourishing basis of our dietary; but we may also prescribe carefully-prepared beef-tea, chicken or mutton broth, or *consommé* containing the expressed juice of vegetables boiled in it, and we may thicken these fluid foods with a small quantity of arrowroot, ground rice, or corn flour.

In cases accompanied with diarrhœa thickening the food with arrowroot will frequently be found very useful. When, owing to great physical depression, some stimulant is needed, small quantities of good brandy is the best stimulant to be given. It may be added to beef-tea, arrowroot, or milk, or given well diluted with soda-water. All wines are to be avoided; occasionally, however, a little champagne mixed with soda-water agrees with some patients; in other cases a little weak tea acts as a useful and refreshing stimulant.

Some of the artificially digested peptonized foods answer well in certain cases, and we have known peptonized milk to be retained and digested when the smallest quantity of unprepared milk would at once excite vomiting.

Upon the disappearance of nausea, vomiting, and pains after food, and with the return of appetite and digestive power, a small quantity of solid food may be cautiously added to the diet, which should, however, still consist mainly of fluid food, and the return to the ordinary diet should be very gradual and carefully watched. It is best at first to add a little pounded beef or chicken to thin broths or clear soups, or to beat up the yelk of an egg with milk, or to add the yelk of an egg to a cup of warm *consommé*. Fragments of stale bread or toast may be soaked in hot milk or may be added to broth or beef-tea; but above all we should be careful to discard at once any article of food which is observed to excite any uneasiness.

On recovery, care should be had to avoid any of the exciting causes of gastric catarrh which we have mentioned, and only the lighter and

more readily digested meats should be taken, and those sparingly and at sufficiently long intervals to allow of their complete digestion—boiled chicken or pheasant, the lean of boiled neck of mutton, well selected, the undercut of the sirloin of beef free from fat, boiled or soused sole or whiting or flounder, or, if grilled, they should be taken without butter or sauce, and with a little salt and pepper or lemon-juice.

Chronic Gastric Catarrh.—This is sometimes a sequel of the acute affection, and it may be caused by the same dietetic errors which we have already referred to as favoring the development of the acute disease. But probably the most frequent cause of chronic gastric catarrh is the abuse of alcoholic beverages, and especially the habit of drinking ardent or but slightly diluted spirits. Chronic gastric catarrh is also an almost inevitable accompaniment of any disease which leads to portal obstruction and consequent congestion of the gastric mucous membrane; it is therefore common to find gastric catarrh existing as a complication of hepatic disease and of those diseases of the heart and lungs which cause obstruction in the vena cava, and so hinder the outflow of blood from the liver and stomach.

It often accompanies pulmonary consumption, and it is always present in chronic organic disease of the stomach itself. It is important to bear in mind that in chronic gastric catarrh the mucous membrane of the stomach is commonly covered with a layer of grayish-white, tough, strongly adherent mucus.

The chief symptoms of this disease are those which are usually described as symptoms of *indigestion or dyspepsia*—viz. fulness, uneasiness, and flatulent distension of the stomach after taking food. Gases are formed by abnormal fermentation and decomposition of the food, which is unduly delayed in the stomach, and these distend that organ, and are often eructated into the mouth, together with fragments of undigested food and rancid, sour fluids. Lactic and butyric acids are generated, chiefly from morbid transformation of starchy foods, and these acrid and sour fluids, when eructated, give rise to the uncomfortable hot feeling described as *heartburn*. In alcoholic cases there is often, especially in the morning, vomiting of a stringy tenacious mucus, or of a quantity of insipid fluid, or of a fluid which is sometimes described as "oily." This symptom is sometimes spoken of as "water-brash." Much of this vomited fluid is thought to be composed of saliva swallowed during the night. The appetite is usually greatly diminished or wholly lost, but sometimes there is an eagerness for food, which, however, is very soon satisfied. Constipation is a common accompaniment of this malady, and so is a condition of mental depression.

The dietetic treatment of these cases should be strict and systematic. In some instances, and especially in those which follow an acute attack,

an exclusive milk diet often answers well, and will, within a moderate period, effect a cure. But it is always necessary to have regard to individual peculiarities in the digestion of milk, and not to insist upon this diet in persons who obviously suffer discomfort after taking it. Before giving it up, however, it may be advisable to endeavor to promote its digestion and assimilation by various means. The milk may be skimmed and much of its fat removed, if that should be the difficulty; or it may be boiled or diluted with hot water; or, what often proves of great service in promoting its digestion, is the addition to it of some alkaline water or one of the alkaline carbonates—one-third of Vichy water and two-thirds milk is a good mixture.

In cases of gastric catarrh produced by alcoholism, when accompanied with great thirst, we have seen excellent results in some persons from a mixture of equal parts of milk and Apollinaris water; and this has been taken in considerable quantity without the least difficulty, provided the tendency to constipation, which commonly accompanies a milk diet, be corrected by a dose of Carlsbad salts every morning before breakfast. Such a dose has the advantage of unloading the portal vessels, which are often engorged, and so tends to lessen the gastric hyperæmia.

Many German physicians have found that *buttermilk* suits some patients better than fresh milk, and we ourselves have observed the same fact in certain instances of chronic gastric catarrh.

Niemeyer quotes with approval the prescription, "When the patient is hungry, let him eat buttermilk; when he is thirsty, let him drink buttermilk;" and he suggests, as an explanation of the brilliant results that sometimes follow its use, that fresh milk is perhaps "not so well borne because it readily curdles in the stomach, and forms large, firm lumps, while in the buttermilk the casein is already curdled, but finely divided."

The tendency to restrict patients who suffer from gastric catarrh to farinaceous foods is often a great error, for in numerous instances such foods lead to the formation of much lactic and butyric acids in the stomach, and help to aggravate the evil they are intended to mitigate. When, therefore, we prescribe farinaceous foods, we should carefully watch for signs of acid fermentation, and should they appear change to other food. In cases where they do not disagree they are valuable in moderate quantity, and light puddings made with arrowroot, sago, vermicelli, or ground rice, or clear meat soups slightly thickened with either of these, are useful articles of diet in such cases.

There is often a difficulty in digesting certain kinds of bread in persons with gastric catarrh, and it is not always easy to say why; but it will be found that bread obtained from the best bakers—bakers who are well known for the good quality of their bread and who take pains

in its manufacture—will often be readily digested, whereas bread obtained indiscriminately will disagree.

Some kinds of whole-meal bread and of brown bread, now so much in vogue, we have found produce gastric irritation and acid fermentation in certain cases, when the finest and lightest and best-made wheaten bread has, in small quantity, agreed with the patient perfectly.

Thin dry toast will often be digested when ordinary bread will not.

All fat meat and sauces must be avoided, and all meats must be well masticated or mechanically reduced to pulp and taken in small quantities at a time. The digestion of animal food is certainly facilitated by a dose of some trustworthy preparation of pepsin.

When solid animal food is not well borne, concentrated meat soups containing a little of the crumb of stale bread may take its place with advantage. In some persons, very prone to the formation of acid, the lean of cold roast meat or fowl, finely divided and taken with a very little white bread, will sometimes suit better than any other food.

It has been noticed by many, and especially by Niemeyer, that some dyspeptics can digest salt and smoked meats better than fresh ones; and the explanation of this is that these preserved meats are less readily decomposed, and do not give rise to acid fermentation in the stomach. Niemeyer mentions that one of his patients who suffered from chronic gastric catarrh, with great tendency to acidity, knew exactly when he must abandon all other food and limit himself to the use of lean and smoked ham, sea-biscuit, and a little Hungarian wine.

Light-boiled eggs are a useful food in these persons. As the process of digestion is slow in these cases, ample time should be allowed for the complete digestion of each meal. It is advisable also that the food, whether animal or vegetable, should be small in bulk, and this can be secured by carefully selecting the best portions of the lean of meat, chicken, game, or fish, and, if necessary, causing them to be finely divided. A certain amount of sound ripe fruit and *purées* of fresh vegetables are useful to counteract the tendency to constipation.

As we have already pointed out, the gastric mucous membrane is, in these cases, covered with a coating of adherent ropy mucus, and it is on this account that a glass of warm alkaline water, like that of Vichy, taken half an hour before a meal, promotes digestion, by loosening and washing away this tenacious layer of mucus, clogging, as it does, the orifices of the gastric glands. The employment of an *exclusively milk diet* in the chronic gastric catarrh induced by abuse of alcohol is strongly advocated by Dujardin-Beaumetz, who also insists on the value of the addition to the milk of some alkaline water or bicarbonate of sodium.[1]

[1] *L'Hygiène alimentaire*, p. 211.

Gastric Ulcer.—The rules that should govern the dietetic treatment of cases of *ulcer of the stomach* are few and simple.

In the first place, we must avoid all food that can, either mechanically or chemically, irritate the surface of the ulcer.

Secondly, we must avoid the use of food that is calculated to stimulate the acid secretions of the stomach, for this will act as an irritant to the raw, ulcerated surface.

Thirdly, we must avoid *distending* the stomach with much food at a time, for by maintaining the stomach in a contracted state, its mucous membrane is thrown into folds, so that the margins of the ulcer are relaxed and its extent diminished—conditions favorable to the filling up and healing of the ulcer.

Fourthly, any excitement of the muscular movements of the stomach should be, so far as possible, prevented.

Lastly, in cases of perforating ulcer, in which severe and dangerous hæmorrhages have occurred and may recur, the stomach should be kept absolutely at rest for two or three days at least, and the patient fed with nutrient enemata, to which, if necessary, a little brandy or port wine may be added, allowing only a few fragments of ice to be sucked in order to allay thirst.

In most cases restriction to an exclusively milk diet will fulfil these indications, and to prevent any firm coagulation of the casein of milk in the stomach we should add some alkaline carbonate or alkaline solution to the milk. In many instances mixing the milk with an equal quantity of lime-water is sufficient, or Vichy water may be used instead. Some physicians, to avoid this curdling of the milk in the stomach, give buttermilk instead of fresh milk. Niemeyer found malt extract a useful food in these cases, and, as a good form of vegetable food, *purée* of potatoes.

If there is a distinct intolerance of milk diet, small quantities of meat or chicken may be given, finely divided or reduced to a pulp (the lean only), and mixed with a little weak broth or *consommé.*

Leube's soluble meat is much used in these cases in Germany. Leube gives some milk also and well-soaked bread. The soluble meat is mixed with slightly salted broth and taken lukewarm.

In those serious cases in which dangerous hæmorrhage has occurred the patient should be kept in bed and fed by nutrient enemata.

If, after a fortnight or three weeks of this strict feeding, the symptoms of the disease have disappeared, we should permit a gradual return to more solid food—the lean of tender boiled mutton or chicken, boiled sole or whiting, light milk puddings, and vegetable *purées;* but we should be careful strictly to limit the amount taken to that required to satisfy the physiological needs of the body.

Stimulating beverages taken by the mouth should be wholly avoided. A little weak tea, with milk, may be permitted in some instances.

Cancer of Stomach.—In this disease the indications are to supply as much nourishment to the body as will adequately meet the nutritive demands and check the progressive emaciation, while at the same time we reduce to a minimum the work of gastric digestion and the pain that is usually attendant upon it. To do this we must give food in such a form that it can be readily absorbed by the vessels of the stomach itself, and cause little or no irritation by its presence there, or food that can readily pass out of the stomach and be absorbed lower down in the alimentary canal.

One important point to keep in view in the feeding of cases of cancerous stricture of the pylorus is to give such food as can be digested and absorbed in the stomach (or predigested food), which will not have to be passed through the narrowed pyloric outlet in order to be digested lower down. It is therefore necessary to avoid, in these cases, starchy, farinaceous foods, unless they are predigested, for they cannot be digested in the stomach, and there is difficulty in their passing out of that organ: the result is, that they are retained there, and give rise to the development of lactic and butyric acids, set up much pain, and lead to troublesome nausea and vomiting.

If the cancerous growth should involve some other region of the stomach, there is then not the same objection to the carbohydrates, because there is not the same risk of their being retained long enough to undergo abnormal decomposition in the stomach.

Food in cancer of the stomach, speaking generally, should be fluid, and sufficiently concentrated to supply the necessary nourishment in a *small* bulk. When milk is well borne no better food can be taken. It is well, however, to dilute it slightly with some alkaline water, and peptonized milk will often be found to agree when ordinary fresh milk will not.

Should any considerable hæmorrhage from the stomach occur during the course of the disease, it may be necessary to limit the administration of food for a time entirely to nutrient enemata, so as to keep the stomach free from any irritation or functional excitement.

As a beverage a little red wine appears to be well borne; beer, spirits, and all sweet and effervescing wines should be avoided.

If the cancerous growth has attacked the cardiac orifice, then nothing but fluid food should be given, as solid food would be arrested above the stricture and cause dilatation of the œsophagus. If the stricture is considerable, it may be advisable to introduce food into the stomach through a tube or to have recourse to rectal alimentation.

Dilatation of Stomach.—Apart from other therapeutic measures, a strict enforcement of dietetic rules is highly needful in this disease.

It is especially important to forbid overloading the distended stomach with food; the food should be concentrated and small in bulk. The supply of liquid should be strictly limited; not more than from 6 to 8 ounces should be taken at each meal. To check any craving for fluid during the meals a teacupful or more of hot water may be sipped half an hour before a meal.

As it is desirable that the food should be concentrated, it must be chiefly animal. The lean of meat from which all fibrous and tendinous structures have been removed is the best.

Starchy foods should be taken only in small quantity, as they are prone to linger in and set up abnormal fermentations in the dilated stomach. Most vegetable substances calculated to give rise to flatulence must be discarded; fresh vegetables must only be taken in limited quantity and in the most concentrated and digestible form. Those that can be taken in the form of *purées* are the best.

Only in severe cases, associated with troublesome vomiting, is it necessary to adopt for a time a strictly milk diet, and in these cases the milk should be given with crushed ice.

Dyspepsia and Indigestion.—The symptoms and causes of dyspepsia need not be dwelt upon here; they are much the same as those of chronic gastric catarrh. As defective mastication is often the cause of certain forms of dyspepsia, either from defective teeth or from carelessness or inattention to this process, food should be given that does not require much mechanical effort for its disintegration—*e. g.* the crumbs of stale bread, dry toast, and some kinds of biscuit, which crumble down and disintegrate readily, whereas new bread is apt to form tough, coherent masses in the mouth. Vegetables should be mashed or reduced to the form of *purées;* potatoes, especially, unless very "mealy," are apt to escape thorough mastication, and to be swallowed in lumps which are likely to prove a source of irritation from abnormal decomposition lower down in the alimentary canal. Fat also should not be eaten in lumps, but should be finely divided and mixed with some other food which will keep the fragments apart. "Bread and butter" is an example of this. When, owing to defective teeth, mastication becomes painful, the meat taken should be first reduced to a pulp or minced or pounded.

Persons with feeble digestions should prefer the shorter-fibred and more easily disintegrated meats and fish: mutton, chicken, pheasant, and partridge are better than beef, goose, duck, wildfowl, etc. Veal and pork are notoriously difficult of digestion, and lamb and rabbit are not so easily digested as some persons believe. Of fish, the sole, whiting, and flounder, when plainly grilled or boiled, are far more digestible than the firmer-fleshed and richer fish.

Grilled (not fried) fat bacon eaten with dry toast often proves an easily digested and good form of fatty food. It disintegrates readily, is

savory, and mixes well with bread; accompanied by the yelks of one or two poached eggs, it forms a nutritious and compact meal.

As we have before had occasion to remark, any food saturated with fat, which prevents the penetration of the gastric juice, such as buttered toast, muffins, pastry, etc., sweet dishes that are apt to undergo acid fermentation, and unripe acid fruits, nuts, and the hard coverings of vegetables containing much cellulose, are difficult of digestion and must be avoided.

It is exceedingly important that the food of the dyspeptic should be carefully and skilfully cooked and agreeably flavored; if food is made palatable and appetizing, it stimulates the nervous system, and so promotes gastric secretion and digestion: grilled meats are perhaps the most digestible and savory.

As to sauces, it is best for the dyspeptic to avoid all rich sauces entirely, and when butter is required, as with fish, to use plain fresh butter.

The indigestibility of bread, or rather of certain kinds of bread, and of too large a quantity of bread, is often overlooked.

A bread which breaks "short," is porous, and crumbles easily, which is not too moist, and yet which does not dry too quickly, and which *does not become glued together* in the mouth in mastication, is the best.

Another point of extreme importance to the dyspeptic is that the meals should be small or very moderate in quantity. Our object should be to select a diet which, while it affords the necessary amount of nourishment to the body, imposes the smallest amount of labor on the stomach.

The food should be slowly and deliberately eaten.

A sufficient amount of time should also be allowed between the meals to permit of the complete digestion of one meal before the next is taken. When the patient is unable to take any solid food, then no doubt it is necessary to take small quantities of fluid food at short intervals; but when solid food is taken, as at an ordinary meal, it must be remembered that from five to eight hours, according to the amount and nature of the food, is needed for its digestion, especially in advanced life and in cases of feeble digestion.

The free use of stimulating beverages, alcohol, tea, coffee, etc., must be forbidden. Whenever there is a craving for alcohol, it is best to forbid it entirely; but in non-alcoholic cases of atonic dyspepsia a small amount of good pure wine, with or without water, or a little weak brandy or whiskey and water, or, if preferred, some effervescing table-water, often serves as a useful stimulus to gastric secretion.

With respect to the use of tea and coffee by dyspeptics much difference of opinion exists. That excess in either, and sometimes quite a

moderate quantity, will excite dyspeptic states in some persons under certain conditions is absolutely certain. Much, however, depends on the time at which they are taken. A person with a feeble digestion should not take them with or soon after food; as they will often retard digestion under these circumstances; but a small cup of weak unsweetened tea or light coffee three or four hours after a meal will not unfrequently be found to promote the final stage of stomach digestion; no food, however, should be eaten at the same time, as is so commonly done. In cases in which even at this distance from a meal they appear to interfere with digestion, it is a good plan to sip a teacupful of hot water instead. Light China teas are much less likely to cause dyspepsia than the stronger Indian varieties.

In anæmic and atonic cases a moderately stimulating dietary answers best, and animal food and soups, well selected and pleasantly flavored with suitable condiments, are better digested than farinaceous foods, which have a tendency to undergo acid fermentation. The meat should be tender and not overcooked. A purely milk diet, which often proves so beneficial in cases of gastric catarrh, is not sufficiently stimulating for the cases we are now considering.

In all these cases individual peculiarities must be carefully studied, especially as to the ease or rapidity with which particular articles of food can be digested.

The cooking should be as simple as possible, so that the natural flavor of the food will be preserved, and any agreeable condiment may be added in moderation; all twice-cooked meats should be avoided.

Green vegetables, unless in very small quantity, especially of the cabbage tribe, should be eschewed, as they are very prone to give rise to flatulence.

Dujardin-Beaumetz, in order to simplify the construction of appropriate dietaries for dyspeptics, divides them into three groups:[1]

1. Those in whom the secretion of gastric juice is abnormally abundant. For these he prescribes a purely vegetable diet—farinaceous substances, fresh vegetables, and fruits. Milk may be used as a beverage, and sometimes beer, but never wine.

2. Those in whom the gastric secretion is deficient. For these he orders meat and meat-broths; but the meat should be reduced to pulp or powder, and the quantity carefully limited to the digestive capacity of the patient. Milk is also admissible, as it augments the digestive power of the stomach by the presence of lactic acid; he also approves of the addition of milk to meat-broths. Wine or weak brandy-and-water he allows, as calculated to increase the acidity of the gastric juice. Peptonized foods may be advantageous in certain individuals.

3. Those dyspeptics who are troubled with sympathetic affections as

[1] *L'Hygiène alimentaire; Du Régime spécial dans les Maladies de l'Estomac.*

giddiness (*vertige stomacal* of Trousseau). For this class he considers it important to lessen the possibility of any excitement proceeding from irritation of the gastric mucous membrane; and to carry out this indication he urges the adoption of a purely vegetable dietary composed of farinaceous foods, fresh vegetables, and fruits, permitting milk as a beverage.

The following is a detailed account of the vegetarian dietary, the adoption of which he considers so important in the case of many dyspeptics:

Bread.—Crust of bread or dry toast.

Farinaceous Foods.—*Purées* of potatoes, of haricots, and of lentils; revalenta; maize flour; chestnut meal; oatmeal; pearl barley, macaroni, and vermicelli; these may be taken plain or with butter.

Fresh Vegetables also in the form of *purées*—carrots, turnips, and the other vegetables used in making Julienne soup; *purée* of green peas, well-cooked salads, spinach, sorrel, French beans.

Fruits should, with the exception of grapes, be cooked, and taken as *compôte.*

With such a *régime* he permits slightly-cooked eggs, and he does not forbid beer.

Leube has found the four following dietaries applicable to the different degrees and stages of digestive disorders. No. 1 is considered to be the most easy of digestion, and is suitable, therefore, to the most severe cases of dyspepsia; No. 2, the next easiest, and so on up to No. 4:

No. 1.—Broth, or clear soup (*bouillon*).
Solution of meat (Leube's special preparation).
Milk.
Eggs, raw or very slightly cooked.
As beverage.—Water, either pure or slightly charged with carbonic acid gas.
This diet is prescribed for cases of gastric catarrh at the outset.

No. 2.—Boiled calves' brains, soups, etc., as in No. 1.
" " sweetbread.
" chicken.
" pigeon.
" bread-and-milk (pap).

No. 3.—The articles in Nos. 1 and 2, to which may be added—
Beef (rump) steak, very underdone, and raw ham (!)
The steak is to be thoroughly beaten, to make it tender, and the most tender portions scraped away with a spoon and roasted quickly in fresh butter.
A small quantity of white bread.

No. 4.—Contains a variety of meats.
Roast chicken, pigeon, partridge, venison, underdone beef (especially cold), veal, macaroni.
A small quantity of wine is allowed with this diet, and also a very small quantity of green vegetables, salad, and stewed fruit.

Constipation.—Sedentary habits and insufficient bodily exercise,

by lessening peristalsis of the muscular coat of the bowels, are well-known causes of habitual constipation.

A too-exclusively nitrogenous diet—a diet too largely composed of easily-digested animal food—by leaving but little waste after its digestion, may lead to constipation from the absence of the stimulus to the nerves of the intestinal mucous membrane which a normal amount of indigestible residue produces; or by too exciting a diet and the repeated contact of a too stimulating residue the excitability of the intestinal nerves may be exhausted and constipation thus induced.

In some instances too dry a diet is taken, and not enough water is consumed to keep the contents of the intestinal canal in a fluid, semi-fluid, or soft condition.

The freer the supply of water to the blood, the more fluid the intestinal secretions are likely to be; whereas if the supply of fluid to the blood be limited, less fluid is likely to be secreted from the intestinal glands, and the intestinal mucous membrane will become dryer. It is no doubt for the reason here indicated that free draughts of cold water taken at bed-time and in the morning fasting will often succeed in overcoming habitual constipation.

Persons who lose much water from the skin by profuse perspiration should also remember this if they suffer from constipation.

Persons who avoid fresh vegetables and fruit should be induced habitually to add some of both to their diet.

Green vegetables and ripe or stewed fruits—as apples, pears, prunes, figs, etc.—and the various kinds of brown or whole-meal bread are well known to have an aperient tendency. This is due to the mechanical irritation which the undigested residue of such foods excites in the intestinal mucous membrane.

Eggs, milk, and most of the farinaceous foods, as they leave but little stimulating residue from their digestion, tend to aggravate the constipated habit.

Oatmeal and maize are also reputed to be slightly aperient, and honey or treacle added to bread or other farinaceous food favors peristaltic action.

"Bran-bread, green vegetables, salads, spinach, sorrel soup (*soupes à l'oiselle*)"—these are the foods containing much indigestible cellulose, which Dujardin-Beaumetz[1] recommends for the relief of habitual constipation, to which he adds "gingerbread (*pain d'épice*)—which, taken in large quantity, is very decidedly laxative"—grapes in quantity, oranges taken with alkaline (Vals or Vichy) water, and *linseed*. "Pour," he says, "a little water on a dessert- or tablespoonful of linseed, let it stand for an hour, and drink the whole immediately before a meal."

[1] *L'Hygiène alimentaire.*

Spanish or Portuguese onions, plainly boiled, will often be found to promote the action of the bowels.

Diarrhœa.—Diarrhœa may be acute and temporary or it may be chronic and intractable.

There is one general dietetic rule that applies to every case of diarrhœa, and that is to avoid all foods which leave much undigested residue behind, and which may therefore tend to produce irritation of the intestinal mucous membrane. We should select and prescribe only such foods as leave a bland and unirritating residue as a result of their digestion, and which ordinarily have no tendency to undergo decomposition into irritating acid substances in the alimentary canal.

Especially to be avoided are green vegetables, raw acid fruits, nuts, potatoes (unless in the form of *purée*), coarse brown bread, and all rich, fat, or acid dishes; also all forms of animal food which are hard or tough and difficult of digestion, such as pork, veal, and beef, unless reduced to pulp or powder.

Milk, preferably boiled, is usually a good food in diarrhœa, unless we find some individual peculiarity rendering it difficult of digestion, and in such cases we must order farinaceous foods, such as arrowroot, tapioca, sago, rice, etc., made with water and flavored with nutmeg, cloves, or cinnamon. An acute attack of diarrhœa will often be rapidly cured by restricting the food for twenty-four hours to very thin arrowroot flavored with the spices we have just named, and with the addition of two or three teaspoonfuls of brandy or a teaspoonful or two of port wine to each teacupful. When beef-tea or clear soup is ordered in these cases, it should be thickened with arrowroot, sago, or tapioca.

Soda-water and milk, with a small quantity of brandy, is the best beverage in acute cases, or port wine and water may be substituted when preferred.

After the subsidence of the acute attack the return to the ordinary diet should be gradual, and for a few days clear soup or beef-tea, thickened with the substances we have named, boiled chicken, partridge, or pheasant with rice, or boiled whiting or sole and a little mashed potato, should be the chief articles of diet. All acid wines and beers must, during this period, be prohibited. The tannin wine of S. Raphael may, however, be permitted.

The dietetic treatment of chronic diarrhœa is a somewhat more troublesome matter. According to Dujardin-Beaumetz,[1] the four following means are those chiefly to be relied upon: 1. Milk; 2. Raw meat; 3. Peptonized foods; and 4. Powdered meat.

A strictly milk diet, according to this author, if rigorously followed, will cure all forms of chronic diarrhœa but one, and that is the diarrhœa of tuberculous ulceration.

[1] *Op. cit.*

After the diarrhœa has been overcome by a strictly milk diet, he allows raw meat, but prefers powdered meat, which is, however, to be given with great caution and increased in quantity gradually and slowly. Peptonized foods may also be tried, and in some instances they may be found to agree better than raw or powdered meat.

As the cure becomes established a gradual return to ordinary diet, especially selecting easily-digested kinds of food, may be permitted.

In the diarrhœa of infancy milk is also the proper remedy—pure fresh milk diluted with lime-water.

It has been shown by Hayem[1] that the "green diarrhœa" (*diarrhée verte*) of infancy is microbic in character, and that it is necessary to disinfect the soiled linen in order to avoid its propagation to other infants. He recommends the administration of a two-per-cent. solution of lactic acid, a teaspoonful to be given a quarter of an hour after suckling.

G. Sée[2] is also a strong advocate of the use of raw meat in the treatment of cases of chronic diarrhœa. He says the fibres are "less compact, softer, and less irritating" than meat cooked in any way; as to the value of milk in these cases he speaks highly, but insists that it should be given in small quantities, and that it should be "skimmed, boiled, and diluted with water," for large quantities of *rich* milk will, he maintains, often augment diarrhœa.

Dr. Stange advocates the koumiss cure in some cases of chronic diarrhœa, and he mentions one case which persisted after an attack of epidemic dysentery, and in which different modes of treatment had been tried for four years; "but the slightest indiscretion in diet invariably brought on the diarrhœa. Six weeks after the commencement of the koumiss cure he had gained four kilos., and could take any kind of food with impunity."[3]

For diet in diabetes see article on that subject.

Food in Albuminuria.—Albumin appears in the urine under a variety of circumstances. We are now only concerned with those instances in which appropriate dietetic treatment is called for, and of these the cases of so-called chronic Bright's disease are by far the most important.

The question whether a diet rich in albumin or an excess of albuminous ingesta can give rise to albuminuria has been investigated experimentally by many observers, with somewhat conflicting results.

It is generally admitted that when albuminuria exists, certain kinds of food will often cause a great increase in the quantity of albumin excreted in the urine; but it is by no means so generally allowed that a temporary albuminuria can be produced by food in the same way as temporary glycosuria can be brought about.

[1] *Académie de Méd.*, 17 Mai, 1887. [2] *Du Régime alimentaire.*
[3] Von Ziemssen's *Handbook of General Therapeutics*, vol. i.

It has been stated that cheese, pastry, and eggs will induce albuminuria in certain persons, but this is certainly a rare idiosyncrasy. Stockvis and some others have stated that in animals and in themselves they have found that when egg-albumin (uncooked) was taken into the stomach in large quantity a portion of it was excreted in the urine. Stockvis suggested as an explanation of this fact that a portion of the uncoagulated albumin entered the blood unaltered, and was therefore eliminated as unassimilable. Nussbaum, Coats, and D'Arcy Power claim to have seen albuminuria produced in the same way. Lauder Brunton, however, failed to produce albuminuria by swallowing six raw eggs in succession, and Dr. Macguire swallowed the whites of twelve raw eggs without producing albuminuria. Another observer[1] ate nineteen raw eggs in thirty-six hours without producing albuminuria.

The occurrence of temporary albuminuria from taking large quantities of egg-albumin, raw or cooked, has been explained by the suggestion that the blood, becoming surcharged with albumin, some of the excess escapes by the kidneys; but may not the true explanation be that the ingestion of so large an excess of albuminous material may throw upon the kidney such an excess of nitrogenous waste, in the form of urea, to be excreted, that a temporary functional hyperæmia of the kidneys is excited, and that this leads to a slight escape of albumin from the blood? It appears to me that this is a sound physiological explanation of what is observed, and accounts for its occurrence in feeble or disordered constitutions, and its absence in the perfectly sound and vigorous.

Dr. Grainger Stewart also tested the effects of some other articles of food, as cheese and walnuts, and came to the conclusion that, although "particular articles of diet induce albuminuria in some people, yet the quantity of albumin is usually minute, and it has little tendency to persist after the resumption of ordinary food."

Pettenkofer and Voit's observations[2] convinced these physiologists that albuminuria was never caused solely by excess of nitrogenous food. Voit gave a dog weighing 35 kilogrammes 2600 grammes of meat in twenty-four hours, and found not the least trace of albumin in the urine; yet the animal had absorbed nearly six times the amount of dry albumin contained in the fluids of its body.

Professor Oertel has also experimented on the effects of the ingestion of egg-albumin. He gave to his dog, weighing only 7½ kilogrammes, the whites of twenty eggs in twenty-four hours by the stomach, and after various trials he never found albumin in the urine. He also gave to one of his patients affected with heart disease, besides 350

[1] Dr. Dobradin, quoted by Grainger Stewart.

[2] Quoted by G. Sée, *Régime alimentaire*, p. 705.

grammes (about 12½ ounces) of meat, 190 grammes (about 7 ounces) of bread and 200 grammes (rather more than 7 ounces) of vegetables; *six raw eggs daily for twelve days*—*i. e.* seventy-two eggs altogether—containing 460 grammes of dry albumin, without finding a trace of albumin in his urine. He obtained, moreover, the same negative result with a patient who ate, on an average, six boiled eggs daily.

It is, then, I think, safe to conclude that the occasionally observed occurrence of albuminuria as a result of the ingestion of albuminous food in excess is an accidental peculiarity or idiosyncrasy, and not an ordinary physiological phenomenon.

With regard, however, to diet in albuminuria when connected with existing renal disease, there is, as I have already said, an almost general consent that richly-nitrogenized food is distinctly prejudicial, and more especially so if it consists of brown meats, of eggs, or of highly-spiced food.

Grainger Stewart has, nevertheless, expressed his belief that in the cirrhotic form of Bright's disease diet is a less important element of treatment than in cases of tubular inflammation; and he gives the particulars of cases in which he ordered eight raw eggs daily in addition to the usual "low diet," without causing any material change in the secretion.[1]

But, as Dujardin-Beaumetz has well pointed out, in dealing with cases of advanced Bright's disease it is not so much the quantity of albumin that appears in the urine that should be our chief concern, but rather the extent of the renal changes and the *consequent retention* of products of nitrogenous waste in the system; and it is to avoid or diminish the risks of this *intoxication* with urinary excreta that our dietetic rules should be directed.[2]

The clear indication, then, is to administer such food as is found to be readily assimilable, and which will tax least the digestive functions, and at the same time furnish the smallest amount of nitrogenous waste calling for elimination by the damaged kidneys.

To fulfil this indication it has been proposed to restrict the food of those suffering from both acute and chronic Bright's disease exclusively or almost exclusively to milk; and it is certain that some of the most remarkable and best results in the treatment of these cases have been obtained from a strict adherence to milk diet. In cases in which this plan of feeding has been well borne it has been observed that the flow of urine has increased, the excretion of albumin diminished, the amount of urea and extractives has been augmented, and the anasarca has disappeared.

But great practical difficulties are often encountered in procuring the adoption of this method by the patients themselves, and in not a

[1] *Op. cit.*, p. 206.

[2] *L'Hygiène alimentaire*, p. 188.

few cases a diet consisting exclusively, or even largely, of milk is not well tolerated.

It has been calculated that from 5 to 7 pints of milk daily will be sufficient for all the food-requirements of an adult.

An exclusively milk diet is thus administered:

If the patient's stomach will bear the sudden suppression of all other kinds of food, the full quantity of milk may be at once taken daily; but if the stomach shows less tolerance of the change, it should be made more gradually, and half a glass or a glass of milk should be taken at suitable intervals, and the other kinds of food slowly and by degrees replaced by it.

The milk should be as fresh from the cow as it is possible to obtain it, and drunk at the ordinary temperature, not boiled and with no flavoring or addition whatever. It is better to take it in small or moderate quantities at short intervals—a glass (6 ounces) every hour during the day, and two glasses on getting up and on going to bed; or when it is inconvenient to take it so often, two glasses may be taken every two hours. When the patient is restricted entirely to milk, it must be remembered that he will require to take from twelve to twenty-four glasses of 6 ounces each in the twenty-four hours.

The occurrence of diarrhœa indicates that the milk is not digested, and then the diet should be altered or modified. If, together with obstinate constipation, an unpleasant taste in the mouth and a dirty tongue appear, the state of the mouth may be improved by sipping a little soda- or seltzer-water after each glass of milk; and the constipation must be relieved by some suitable aperient—a little Gregory's powder, or compound liquorice powder, or citrate of magnesium, or a capsule of castor-oil, or a teaspoonful of Carlsbad salts or an aperient enema.

The body-weight usually diminishes somewhat during this treatment; the urinary secretion is often increased to a remarkable extent, and this diuresis is generally accompanied by a disappearance of dropsy, if it exists.

The abundant urine is pale, clear, with a peculiar greenish-yellow reflection, said to be characteristic of the milk diet; it is usually of low specific gravity, on account of the quantity excreted, and of diminished acidity; the amount of albumin excreted will usually be observed to diminish gradually from day to day, while the proportion of urea and salts is progressively increased.

The period during which the treatment should be maintained cannot be fixed with any strictness. It must depend upon the nature of the case and the progress of the patient.

If we are treating a case of acute nephritis, and have adopted the exclusively milk diet from the commencement, three or four weeks

may suffice to get rid of the albuminuria, and we may slowly and gradually return to the ordinary diet.

In chronic parenchymatous nephritis (inflammation of the tubules) the result of treatment will depend upon the age of the patient and the duration and extent of the kidney lesions.

In advanced cases, in which cure is not possible, considerable amelioration in the general condition of the patient may constantly be observed, together with an increased flow of urine, disappearance of dropsy, a steady diminution, little by little, of the amount of albumin, and, although it may not entirely disappear, at the end of six or eight weeks it will be reduced to a minimum. The kidney lesions are irreparable, but the milk diet has lessened, in a great measure, the excretion of albumin, and has restored a proper elimination of the nitrogenous and other urinary excreta.

In cases of cirrhotic or interstitial nephritis (gouty contracted kidney) an exclusively milk diet is less urgently indicated. When, however, the cardiac compensation begins to fail and symptoms of uræmia are threatening, then great advantage may follow the adoption of this mode of treatment.

We are in ignorance at present as to the precise manner in which the milk acts on the organism or on the diseased kidneys so as to produce the beneficial results observed.

In those cases in which an exclusively milk diet is badly borne or absolutely rejected by the patient we must fall back on some other method of feeding.

We should, in the first place, endeavor to induce the patient to accept a modified milk diet, and supply him with dishes largely composed of milk, but which have the advantage of some agreeable flavoring, without which foods of all kinds are repugnant to many.

Milk may be made the basis of soups, to which various vegetable flavoring substances may be added, as onions, celery, and the usual aromatic herbs commonly employed for such purposes, together with a little salt and pepper; fragments of toasted bread may be served with these milk soups. Arrowroot, tapioca, rice, and vermicelli may be used to thicken milk, and a little grated lemon-peel or cloves or nutmeg may be used to flavor foods thus made, or a small quantity of fruit-jelly, such as red-currant jelly, may be eaten therewith.

On leaving off the exclusively milk diet the patient should be permitted, by slow degrees only, to return to the ordinary diet.

At first a little arrowroot, tapioca, or rice should be substituted for a portion of the milk; then a little fish, chicken, or other white meat, and a little green vegetable, or cooked fruit, and a small quantity of good sound Bordeaux wine, mixed with seltzer-water, may be taken with the midday meal.

Should the attempt to return to a mixed diet be attended with an increase in the quantity of albumin excreted, the exclusively milk diet must again be resorted to.

It must, of course, be borne in mind that an irreparably damaged kidney cannot be made structurally sound by milk diet or by any other remedy; and in such cases, after the albumin has been reduced to a minimum by the milk diet, a return to a carefully-arranged mixed diet may not only be justifiable, but advantageous.

Oertel, Grainger Stewart, and others have shown that in many such cases a diet rich in albumin is well tolerated, and not attended with any notable increase in the amount of albumin excreted in the urine.

It is in acute cases, and especially in those cases which seem to be passing from acute to chronic, and before the structure of the kidneys has been hopelessly damaged by inflammatory and degenerative changes, that the exclusively milk diet is attended with such brilliant results.

In those cases in which, for some reason or other, the milk diet is inadmissible, we have to consider what is the best alternative.

It has already been pointed out that the subjects of albuminuria must carefully avoid any excess of nitrogenous food. Senator recommends that animal food should be altogether avoided, or limited to, at most, a little white meat, while all kinds of vegetables and fats are permissible. Dujardin-Beaumetz also testifies that he has obtained excellent results by restricting patients with albuminuria to vegetable food. Farinaceous food, fresh vegetables and fruit, together with milk, butter, cream, and other fats, afford all that can be needed for the nutrition of the body.

Dujardin-Beaumetz commends the onion, especially, as an addition to soups; and he states that when he has found his albuminuric patients unwilling to relinquish meat, pork has appeared to him to increase the amount of albumin excreted less than other meats, and he is therefore in the habit of recommending to them either ham or cold roast pork, and the fat in particular. He differs from Senator in not thinking well of fish in these cases; he believes it notably increases the amount of albumin in the urine. As cheese is a highly albuminous food, it should be avoided altogether or taken only in very small quantity.

As a beverage he prefers milk, so long as the patient can tolerate it; all spirits and undiluted wines and all kinds of beer he forbids entirely.

Food in Gout and Uricæmia.—Chiefly by the labors of Garrod three facts have been established with certainty in connection with gout: 1st, that in the gouty there is an excess of uric acid in the blood; 2d, that during an attack of gout there is a diminution of uric acid in

the urine, often by one half; and 3d, that at the end of an attack there is an excess of uric acid in the urine. And these facts are interpreted as meaning that before, and especially during, an attack the blood is surcharged with uric acid, and that at the end of the paroxysm this excess is discharged in the urine, and the patient is, for a time at any rate, free from his uricæmia.

But although it is generally admitted that in gout there is an excess of uric acid in the blood, it is not certain whether this is due to an abnormally large *production* of uric acid in the body or simply to its abnormal *retention*.

The deposition of uric acid in the bodies of the gouty may be simply dependent on a diminished power on the part of their fluids to hold the salts of uric acid in solution; and this inability to hold the uric-acid salts in solution may depend on an abnormally acid state, or, what is the same thing, a diminished alkalinity of those fluids.

It was held, and is still held by many, that uric acid represents a low grade of oxidation of the nitrogenous waste necessarily produced in the metabolism of albuminous foods, and that when such foods are taken in great excess they cannot be completely oxidized into urea, which is very soluble and readily eliminated, and that, consequently, an abnormally large proportion is converted into uric acid, representing a lower grade of oxidation; and the salts of this acid being very insoluble, are less readily eliminated, and therefore tend to accumulate in the blood and to be deposited in the body.

This view of course traces gout to an excess of nitrogenous ingesta. But if we refer gout to a deficient alkalinity and diminished solvent power of the fluids, however brought about, we get a wider, and perhaps a truer, grasp of the causation of the disease; for while this view recognizes the causative influence of an excess of albuminates in the food, it does not exclude other causes, which we must take into consideration in explaining the occurrence of this disease in many persons.

It has been noticed (Voit and Hoffmann) that strongly acid urines show a tendency to deposit sediments, and it has been pointed out that in the metabolism of albumin the sulphur and phosphorus contained in it become converted into sulphuric and phosphoric acids, all of which may not be completely neutralized, and may be sufficiently in excess to augment the acidity of the urine; so that an excess of albuminous food may contribute to the deposition of insoluble salts of the uric acid by diminishing the alkalinity of the fluids; which, indeed, it is known to do. In the same way, those dyspeptic conditions which are so common in some gouty persons who are not large feeders may tend to an increased formation of the organic acids, and so to a reduction in the alkalinity of the blood, and thus bring about *uricæmia—i. e.* a retention of uric acid in the blood.

Thus we already see that one of the most important dietetic indications in the treatment of the gouty is to maintain the normal alkalinity of the fluids and to maintain or augment their solvent power; and precisely the same indication with regard to food applies to the tendency to the formation of uric-acid gravel and calculi.

As I have already pointed out, it is a well-established fact that a highly nitrogenized animal dietary increases the acidity of the fluids of the body, and especially of the urine; and it is equally well known that a vegetable dietary increases the alkalinity.

One of our chief objects, therefore, in constructing a dietary for the gouty is to diminish, within suitable limits, the amount of animal food they consume, and to replace it with an equivalent quantity of appropriate vegetable substances.

The extent to which this can be carried with safety will depend upon the habits of life, the occupation, and the digestive peculiarities as they are met with in individual cases.

For the indolent and sedentary animal food should be reduced to a minimum; to the energetic and active a more liberal proportion may be allowed. But in all cases we must, above all things, avoid exciting dyspeptic states by an unwise stringency of dietetic rules ill adapted to the digestive peculiarities which many of these patients present.

Great moderation in the consumption of animal food is, then, one of the first rules for the gouty.

It is also the experience of the majority of authorities that in the food of the gouty *fats* as well as albuminates should be reduced to the minimum; fatty, saccharine, and gelatinous foods, by interfering with the complete metabolism of the albuminates, tend to the production of uricæmia. Bauer points out that we ought not only to restrict the amount of fat in the food, but that, as corpulent persons perspire freely, and therefore, as a rule, secrete a concentrated urine liable to yield deposits, we should also adopt other means to prevent the accumulation of fat.

Germain Sée insists especially on the prejudicial effects upon the gouty of a diet rich in nitrogenous food when combined with sugar, gelatin, and fats.

Ebstein, however, advocates the consumption of a moderate amount of fat, so as to diminish the quantity of carbohydrates needed, as he regards these as the most fattening of all foods. He also considers fat useful as quickly satisfying the appetite and diminishing the desire for food.

We see no reason for withholding a moderate amount of fatty foods from gouty persons who show signs of defective nutrition, provided they digest them without difficulty; but, on the other hand, we should restrict them as much as possible in the diet of the corpulent and well-nourished.

It is a grave error to impose on the gouty a too rigorous abstinence. Their diet must contain all that is needed for the due nutrition of the body and for maintaining its functional activity. It must therefore be proportioned, in some measure, to the work and activities of individual organisms; but it is a wise precaution at all times to draw the supplies of food, so far as practicable, from the more readily digested and more nutritious vegetables.

Green vegetables and fresh fruits are especially suitable, as they are known to render the urine more alkaline, while they do not favor the deposit of fat in the body; but an exclusively vegetable diet is by no means to be commended, save in quite exceptional instances.

The feeble digestion of many gouty persons is quite unequal to appropriating that comparatively large mass of vegetable food which is necessary to supply the wants of the system, and a certain proportion of more concentrated and easily-digested animal food is therefore necessary for them.

White are generally considered more appropriate than *brown* meats, and, bulk for bulk, this may be true. But there is no proof that small quantities of well-cooked and tender mutton or beef are more prejudicial to the gouty than larger quantities of chicken and rabbit; indeed, the latter, although a white meat, has often appeared to us more difficult of digestion than beef and mutton.

There is a general consent that smoked and dried or pickled pork, game, fish, and other meats should be proscribed, as they all present very condensed forms of nitrogenous food, and excite thirst, which is not always quenched with pure water. Rich and fat sauces should be altogether avoided, and all *entrées* and made dishes which are served with sauce. Strong meat-soups and extracts are also particularly undesirable; and when soups are taken they should be vegetable soups, only slightly flavored with animal extract. One teaspoonful of Valentin's meat-juice added to half a pint of a purely vegetable soup imparts quite as much of this flavor as need be desired.

Cheese, as one of the most concentrated forms of nitrogenous food and as often difficult of digestion, should be avoided.

As the yelk of egg contains a large amount of fat and lecithin, eggs should enter as little as possible into the dietary of the gouty.

Fish, oysters, and the crustaceæ (crabs and lobsters) must be partaken of sparingly; the rich and firmer fish, such as salmon, mullet, mackerel (and perhaps lobster and crab), had better be altogether avoided.

An almost unlimited choice of fresh vegetable food may be permitted—potatoes and the ordinary green vegetables and salads. Sorrel, tomatoes, and asparagus have, however, been especially prohibited, on the ground that they contain oxalates, and oxalic acid is a congener of uric acid. But we have been recently assured that it is an error to

proscribe tomatoes, as they contain but a very small amount of oxalic acid, whereas spinach, which has been so universally approved of, is, next to sorrel, the richest in this acid.[1] Asparagus, if eaten without melted butter, we see no practical objection to.

Those dry vegetables which are both rich in albuminates as well as in carbohydrates, such as haricot and other beans, peas, and lentils, should be partaken of only in small quantity. Mushrooms and truffles are prohibited.

Bread, which is also a highly nitrogenous food, should be taken only in moderation, and is perhaps least harmful when well toasted. Bouchardat has proposed to substitute potatoes for it.

Most fresh, ripe fruits are wholesome, and most cooked fruits, as stewed or roasted apples, etc.; but the highly saccharine fruits, whether fresh or dry, are not so suitable, and should be taken in very moderate quantities.

As to the best beverages for the gouty, and first as to milk: some differences of opinion exist with regard to milk, and no doubt there are great individual peculiarities in respect of its digestibility. Some cannot digest it at all, some dislike it excessively, and others can digest it in any quantity and are fond of it. For the latter we consider that it serves as an admirable form of food, especially if skimmed or diluted, presenting, as it does, all the principles necessary for the nutrition of the body in a form readily assimilated by those with whom it agrees, and containing a large quantity of water. It is an advantage to render it slightly alkaline by adding to it a little alkaline water, such as Vals or Vichy water, when it often acts freely as a diuretic. Indeed, we are in the habit of advising our gouty patients and those who have shown any tendency to the deposition of uric-acid gravel to drink, about ten minutes before their first meal, a breakfast-cupful of hot milk and water to which a small level salt-spoonful of bicarbonate of potassium and the same quantity of table salt should be added. In this form, well diluted and rendered distinctly alkaline, we can see no objection to the use of milk.

Ebstein has maintained, and Germain Sée also, that of those who deposit uric-acid gravel, there are some whose urines do not contain an excess of uric acid, but that this acid is deposited simply because these urines are not in a condition to hold it in solution: either they do not contain enough water or they may contain an excess of acid phosphates, which combine with the soda needed to hold the uric acid in solution; it thus becomes free, insoluble, and deposited in the crystalline form. In such instances the value of an abundance of slightly alkaline watery beverages is very obvious. A draught of hot water half an hour before a meal or at bedtime, and the use of the alka-

[1] Dujardin-Beaumetz, *L'Hygiène alimentaire*, p. 169.

line table-waters to mix with wine or whatever stimulant is taken, should be recommended. The habit of drinking, in some form or other, a considerable quantity of water is an important point in the dietary of the gouty ; and whatever wine or spirit they take should be largely diluted, either with pure water or with an alkaline effervescing table-water. The value of drinking considerable quantities of hot water has been largely insisted on by many physicians, and we have had occasion to form a favorable opinion of the practice if kept within certain limits.

Strong beers, porter, and stout should be avoided by all gouty persons. We have known a few instances in which stout has been well borne, but a large quantity of alkaline salts were at the same time taken habitually.

Of wines, those which are strong, sweet, or spirituous should be carefully avoided, such as sweet or strong champagnes, ports, sherries, Madeira, Burgundy, and the stronger clarets. All wines which contain much sugar, alcohol, tannin, or free acid are unsuited to the gouty. Still Moselle, light hock, some of the best Hungarian wines, light, well-kept, fine-quality Bordeaux,—all these are permissible in small quantity, diluted with an alkaline table-water, so as to neutralize any free acid they may contain. The more distinctly diuretic the effect of the wine, the better, as a rule, will it agree with the gouty.

With regard to alcoholic beverages in general, it may be said, unhesitatingly, that the gouty persons who can do without them entirely are wise to do so. If they cannot exist comfortably without a small or moderate amount of alcoholic beverage, then they must exercise great care in its selection. There is all the difference in the world between the effects of a fine, mature, high-quality wine or spirit and the commoner kinds of the very same beverages. They should always be well diluted. Of spirits, the best are fine old Scotch whiskey, dry Plymouth gin, and the finer kinds of French cognac, when they can be obtained.

Both tea and coffee, when not strong, are exceedingly useful beverages to the gouty, unless they are found to disturb the digestion, which they will do with some persons. In that case it is necessary to take them without sugar. It is the quantity of sugar so commonly taken with these beverages that helps to make them injurious.

The best China tea, and not Indian tea, should be employed for infusion, as the latter contains far too much tannin.

For diet in obesity see article on that subject.

Food in Leanness and Defective Nutrition.—If it is sometimes difficult to reduce the proportions of the corpulent, it is usually far more so to increase the weight and plumpness of the thin and emaciated. This arises from the circumstance that many cases of emacia-

tion and defective nutrition depend on the existence, latent or declared, of serious organic disease; in others there seems to be an hereditary tendency to leanness; and in others the defective nutrition depends on a neurasthenic state, and in still others on grave functional disturbances of digestion. When definite disease of the digestive organs, organic or functional, can be detected, the dietetic treatment of such cases must be in acccordance with the rules already laid down for the management of such diseased conditions. Restless states of the nervous system, associated with worries and anxieties, present insuperable obstacles to improving the nutrition of the organism; and these must first be allayed before any lasting advantage is likely to be gained from an appropriate dietary.

The same principles that guide us in framing a *régime* which shall arrest the progressive emaciation of the neurasthenic and the consumptive patient will be found to apply to those less grave forms of leanness which we are called upon to treat, and where we cannot detect the presence of any serious malady.

For the appropriate dietetic and other management of those cases of neurasthenia or nervous exhaustion in which the general nutrition is so gravely affected that quite phenomenal states of emaciation and muscular feebleness are observed in connection therewith, we are mainly indebted to Dr. S. Weir Mitchell. These cases cannot, however, be restored to health by appropriate food alone, but other curative agencies have to be simultaneously and systematically employed. These are complete isolation, rest in bed, and the regular application of massage and electricity. To use Dr. Mitchell's own words, the method consists of "a combination of entire rest and of excessive feeding, made possible by passive exercise obtained through the steady use of massage and electricity."[1] He insists on the intimate association between the gain and loss of fat and the gain and loss of blood-corpuscles. "The loss of fat . . . . nearly always goes along with conditions which impoverish the blood; and, on the other hand, the gain of fat, up to a certain point, seems to go hand in hand with a rise in all other essentials of health, and notably with an improvement in the color and amount of the red corpuscles. . . . . To gain in fat is nearly always to gain in blood." It may also be well to let Dr. Mitchell himself describe the cases to which he considers his method especially applicable. They are "people who are kept meagre, and often also anæmic, by constant dyspepsia in its varied forms, or by those defects in assimilative processes which, while more obscure, are as fertile parents of similar mischief. . . . . That large group of women especially said to have nervous exhaustion or who are defined as having spinal irritation, ...

[1] *Fat and Blood: An Essay on the Treatment of Certain Forms of Neurasthenia and Hysteria*, 5th ed., 1888.

cases in which, besides the wasting and anæmia, emotional manifestations predominate, and who are then called hysterical, whether or not they exhibit ovarian or uterine disorders; . . . . women who have lost flesh and grown colorless, but have no hysterical tendencies, ... hopelessly below the standard of health, and subject to a host of aches and pains, without notable organic disease."

The large amounts of food given in this method while the patient takes no exercise are absorbed and utilized through the influence of massage, "kneading the muscles, and by moving them with currents able to effect this end." To ensure the most absolute rest in cases of great weakness the patient is fed by a nurse, and when well enough to sit up in bed the meats are cut up, so as to make it easier for the patient to feed herself.

The treatment is begun by putting the patient on milk diet—three or four ounces every two hours, increased in a few days to two quarts, given in divided doses every three hours. This, says Dr. Mitchell, "nearly always dismisses, as by magic, all the dyspeptic conditions." The bowels are regulated by giving a cup of coffee, without sugar, on waking, or a pill of watery extract of aloes at bedtime, or in more obstinate cases a quarter of a grain of watery extract of aloes and two grains of dried ox-gall thrice a day.

After from four to seven days a light breakfast is permitted; a day or two later a mutton chop as a mid-day dinner; and again, in a day or two, bread and butter thrice a day. After ten days, usually, the patient is allowed three full meals daily, as well as three or four pints of milk, given at or after meals, in place of water, and from two to four ounces of fluid malt extract before each meal.

"No troublesome symptoms usually result from this full feeding, and the patient may be made to eat more largely by being fed by her attendant. I like to give butter largely, and have little trouble in getting this most wholesome of fats taken in large amounts. A cup of cocoa or of coffee with milk on awaking in the morning is a good preparation for the fatigue of the toilet. At the close of the first week I like to add 1 lb. of beef, in the form of raw soup. This is made by chopping up 1 lb. of raw beef, and placing it in a bottle with one pint of water and five drops of strong hydrochloric acid. This mixture stands in ice all night, and in the morning the bottle is set in a pan of water at 110° Fahr., and kept two hours at about this temperature. It is then thrown on to a stout cloth and strained until the mass which remains is nearly dry. The filtrate is given in three portions daily. If the raw taste prove very objectionable, the beef to be used is quickly roasted on one side, and then the process is completed in the manner described above. The soup thus made is for the most part raw, but has also the flavor of cooked meat.

"In difficult cases I sometimes add, at the third week, ½ oz. of cod-liver oil, half an hour after each meal. If it lessen appetite or causes nausea, I employ it thrice a day as a rectal injection, and in cases where the large doses of iron used cause intense constipation I find the use of cod-liver oil enemata doubly valuable, by acting as a nutriment and by disposing the bowels to act daily. When given thus, I like to use it in an emulsion made with the juice drained off, after crushing the fresh pancreas of the beef in warm water. Enough of water to cover ½ lb. of chopped pancreas is allowed to stand for an hour in a warm kitchen, and then squeezed through a towel. An ounce is mixed with half that amount of oil and injected slowly thrice a day."—*Weir Mitchell.*

As to stimulants, when there is no question of breaking off the alcoholic habit, a small amount of stimulant has been found to assist in the rapid increase of fat, such as an ounce of whiskey daily in milk, or a glass of dry champagne, or Burgundy or other red wine. It increases the capacity to take food at meals. Alcohol, however, is not essential.

With the administration of *solid* food iron is given in large doses, and when the patient is able to sit up "rather full doses of sulphate of strychnine thrice a day, with iron and arsenic."

As to the consumption of this "vast amount of food," Dr. Mitchell observes: "I have watched again and again, with growing surprise, some listless, feeble, white-blooded creature learning by degrees to consume these large rations, and gathering under their use flesh, color, and wholesomeness of mind and body."

When the patient is taking the full diet it is necessary to watch the urine. When urates begin to be deposited, it must be regarded as a sign of overfeeding, and some reduction in the quantity of food must be made. Attacks of dyspepsia (which are apt to occur) or diarrhœa are met by reducing the diet one-half or returning to a milk diet for a day or two.

In all these cases the milk should be well skimmed and slowly taken in mouthfuls at a time. It may, when necessary, be flavored with a little tea or coffee or caramel or salt. Its digestion is often aided by scalding with one-fourth the quantity of boiling water, and a few grains of bicarbonate of sodium or a little alkaline water—Vichy, Vals, or Apollinaris—may be added.

In the dietetic treatment of the malnutrition and emaciation of consumptives it is a generally accepted rule that fats and carbohydrates, the especially fattening forms of food, should take a prominent place. A proper proportion also of albuminates must be included in their dietary. One of the greatest difficulties we encounter in providing a suitable and adequate diet for consumptives is the frequency with which they complain of digestive troubles, want of appetite, and occasionally of

positive disgust for food. Under such circumstances it is most important to provide well-cooked, appetizing, and attractively-served food, varied as much as possible, and, so far as is consistent with wholesomeness, agreeable to the tastes of the patient. In the distinctly febrile forms it will be advisable to give small quantities of nutritious food at short intervals.

Phthisical patients whose digestive functions are unimpaired may be allowed to partake of the various nourishing forms of food that enter into the ordinary dietary of the healthy, in addition to which two or three glasses of milk should be taken at convenient intervals between meals, and one of these glasses of milk should be taken the last thing at night, or preferably during the night if the patient is awake.

Milk is a most valuable food for the consumptive, and we have already mentioned the several expedients which may be adopted for promoting its digestibility when it is not well borne.

By adding to each glass of milk two tablespoonfuls of hot water in which about six grains of bicarbonate of sodium and five grains of common salt are dissolved, we can often remove the difficulty in the digestion of milk, particularly when the milk is very rich. When we find evidence that the patient really cannot digest the casein of milk—*i. e.* when we find hard curds of milk rejected by vomiting or giving rise to intestinal troubles and forming the chief part of bulky white motions—then we should make use of whey as a beverage. Its mode of preparation has already been described. A little cream may be added to it if desired.

Cream may also be made more digestible and more acceptable to many patients by mixing it with an equal quantity of hot water, and adding to each teacupful of the mixture a teaspoonful of the aromatic spirit of ammonia, although some prefer a teaspoonful of brandy. In other cases we may use peptonized milk.

Germain Sée considers the peculiar value of milk in phthisis to depend upon the fat it contains, and he argues that when enough milk is taken to provide the requisite amount of the other elements necessary for the nutrition of the body, the fatty constituents are in large excess, and this he regards as its great recommendation. For an exclusively milk diet he estimates the necessary quantity at 3 litres (105 ounces), rather more than 5 imperial pints.

In many summer health-resorts[1] in Switzerland and Germany provision is made for following a "milk or whey cure," and in most of these sheep's, goat's, and ass's milk, as well as cow's milk, can be procured. There is no reason, however, for believing that goat's milk is more digestible than cow's milk, but in the case of diarrhœa it is thought to be preferable on account of the lime salts it contains. Ass's

[1] See my work on *Climate and Health-Resorts* (new ed.).

milk, however, like mare's milk, can often be taken when cow's milk has proved indigestible.

The utility of fatty substances in phthisis is undoubted, and in those cases in which we encounter an insuperable difficulty in procuring the acceptance or the digestion of cod-liver oil we may encourage our patients to consume as much fresh *butter* and good *cream* as they can digest.

Excellent results have been obtained, even in some advanced cases, from the administration of cream. We have already mentioned a suitable mode of giving it. Some order a little rum or brandy to be mixed with it. The addition of sugar or salt is said to aid its digestion, or it may be mixed with a little tea or coffee when these beverages do not disagree.

Cocoa and chocolate contain a notable quantity of fat, and are useful forms of food. Pancreatic emulsion will often be found serviceable when there is difficulty in digesting other forms of fat. Variety in food is most important, as well as its skilled preparation and cooking, and nearly all kinds of animal food, when suitably cooked, may be given to the consumptive.

The use of raw meat has been highly extolled, especially by some French physicians, and Professor Fuster of Montpellier has claimed the most brilliant results from its administration in cases of phthisis. These results have not, however, been confirmed by other observers, although it is generally admitted that in many cases of troublesome dyspepsia and loss of appetite, especially when associated with diarrhœa, raw meat has rendered real service.

Various expedients have been adopted to overcome the repugnance which most patients at first manifest for this form of food.

In all cases it should first be reduced to as fine a state of subdivision as possible by scraping or cutting and pounding, or, better still, by the use of the little machines now made for this purpose.[1] Raw meat may also be reduced to a fine dry powder by first drying and then grinding it.

Pounded raw meat can, however, be made up into small round pellets, and covered with powdered sugar or gum or any other innocent covering, and swallowed with a little wine and water or brandy and water, or it can be mixed with a little hot clear soup. And it is especially well borne mixed with light tapioca soup; this can be flavored with any agreeable flavoring and drunk readily, and the mouth cleansed by

[1] Debove recommends that it should be "scraped with a knife, so as to detach all the muscular fibres and separate them from the fibrous tissues;" and he points out that what renders it so valuable as a food is its extreme subdivision, which multiplies the surfaces of contact and allows each fibre to be completely bathed by the digestive juices; also, as it has not been hardened by cooking, it allows these juices to penetrate it more readily.—*La Tuberculose parasitaire*, p. 77.

drinking a few mouthfuls of weak brandy and water or claret and water after it.

In some parts of Germany the roes of salted herrings, and in France several species of snails, are thought to be especially useful as food for the consumptive.

The different kinds of farinaceous foods are all useful and appropriate articles of diet. Whole-meal or well-made brown bread is, on account of the phosphates contained in it, better suited to young consumptives, if they digest it well, than white bread. Lentil flour is also valuable, as it contains notable proportions of phosphates and of iron. Oatmeal is rich in fatty matters, and the flour of maize is still richer—a fact which renders them both very suitable additions to the diet of the tuberculous.

Malt extract is now largely employed as an addition to farinaceous food, the digestion and assimilation of which the *diastase* contained in it doubtless facilitates. It is possible also to procure malt bread and malt biscuits.

With regard to the use of alcoholic beverages, much difference of opinion exists. Some advocate the consumption of large quantities of alcohol in phthisis. Flint[1] quotes cases which appear to have been benefited by the consumption of as much as a pint of whiskey daily! We shall find, practically, that the use and need of alcohol vary greatly in different individuals. In some it diminishes appetite and retards digestion; in others it promotes both; and we shall encounter very few cases of phthisis which are not benefited, at some period of their course, by the discreet administration of alcoholic stimulants.

It is exceedingly necessary that the beverage, whether wine, spirits, or beer, should be pure and of the best quality.

When the patient is able to drink fermented *malt* liquors, he may be allowed one or two pints daily of good sound bitter beer or porter or stout; of wines, half a pint to a pint of really good Bordeaux or Burgundy, or of some of the better descriptions of Hungarian, Italian, or Greek wines. Port and sherry we have found objectionable in most cases, disturbing digestion and often causing headaches; a proportionate quantity of whiskey or brandy is preferable to either of these wines.

Food in Anæmic Conditions.—Closely allied to states of malnutrition and emaciation are the anæmic conditions so commonly encountered amongst young females, especially about the age of puberty; and it will be convenient now to call attention briefly to the appropriate dietetic treatment of such cases.

Among the various causes of anæmia or hydræmia—by which is meant an alteration in the composition of the blood, so that it becomes

[1] In his work on *Phthisis.*

poorer in red corpuscles and more watery—a defective or unsuitable supply of food must be regarded as one of the most frequent.

It has been proved that with a diet composed of exclusively non-nitrogenous food the percentage of hæmoglobin in the blood undergoes a notable diminution, while it is augmented by a diet rich in albuminates.

It is certain that much of the chlorosis, anæmia, and associated nervous disturbances observed amongst young girls at the age of puberty is referable to improper or insufficient feeding at school, together with the imposition of educational tasks to which they are unequal.

The more acute form of anæmia may be caused by hæmorrhage or may be the result of severe illnesses, and in the latter case considerable emaciation generally accompanies it.

With suitable food recovery is very rapid in most of these cases, and a moderate loss of blood is soon made up; the fluid part is, however, more quickly restored than the corpuscles.

In some chlorotic females it has been said that the heart and blood-vessels are abnormally small, so that they suffer from a congenital weakness in the blood-forming and blood-propelling apparatus; in such instances not only must great care be observed in the regulation of the diet, but all the organs of the body should be guarded from undue strain or any over-exertion.

In all cases of anæmia not only must we see that the supply of food is adequate and its quality suitable, but we must also watch over its digestion and assimilation. The functional disturbances which are associated with poor and watery blood are especially marked in the digestive organs, the secretions of which become defective both in quantity and quality, and dyspeptic troubles are therefore common accompaniments of the anæmic state.

It may often be observed in anæmic persons that while their muscles are feeble and wasted, they present a generally plump aspect, from the presence of a considerable amount of adipose tissue. This has been referred to defective oxygenation from the decrease in red blood-corpuscles, the carriers of oxygen, and consequent imperfect combustion of the hydrocarbons and carbohydrates.

From these considerations we are able to deduce the following indications for the dietetic treatment of cases of anæmia and chlorosis:

1. The food should contain the elements needed for the restoration of the deficient blood-corpuscles and the general normal integrity of the circulating fluid.
2. It should be directed to restoring tone to the enfeebled muscles, and especially to the cardiac muscle.
3. It should be supporting and soothing to the exhausted and irritable nervous system.

4. It should be of a kind and in a mode of preparation which renders it easily and quickly appropriated by the organs of digestion and assimilation—processes especially languid and feeble.

At the outset of the treatment *rest* of the exhausted organism should be particularly enforced. The tendency to urge the young who are feeble and anæmic to take abundant exercise, and to make them follow the same mode of life as their healthy associates, cannot be too strongly condemned. It interferes with the success of all our remedial measures.

The food given at first should be in small or moderate quantity, so as not to overtax the feeble digestive powers, and in a form that can be readily digested.

Milk, skimmed if necessary, is most useful when it is easily digested; but it must not be persevered with when it is digested with difficulty, and is on that account distasteful to the patient. Peptonized milk, a breakfast-cupful twice or three times a day, may be given when unprepared milk disagrees.

All forms of animal food, prepared in a manner easy of digestion, are useful and appropriate. Raw or slightly-cooked meat, pounded or scraped and mixed with agreeably-flavored consommé or meat-broth, or made into sandwiches, or mixed with chocolate or Burgundy and water, or given in any wholesome form approved of by the patient, is of great value as a blood-restorer.

Germain Sée states that he has often cured cases of chlorosis without iron, or after iron has failed, by the administration of 400 grammes (about 14 ounces) of raw meat daily, together with hydrotherapy; and he considers those two means as indispensable in the treatment of dyspeptic chlorotics who cannot take iron, and the former also in those cardiac cases which cannot tolerate either iron or hydrotherapy.[1]

The digestive power for nitrogenous or other foods must be carefully watched, and, if necessary, aided by the addition of some appropriate digestive ferment. A few grains of pepsin may be given with each meat meal.

To obviate the tendency to constipation, well-made whole-meal bread may be given, watching again carefully for any signs of indigestion which it is apt occasionally to provoke. For the same purpose oatmeal porridge may be taken at breakfast, and some fruit *compôte*.

Green, fresh vegetables, especially in the form of *purées*, are also to be recommended for the same purpose. Maccaroni, vermicelli, polenta, and the various Italian pastes, cooked with meat-juice or gravy, are excellent.

Animal albuminates should predominate in the diet at first, given in quantity proportionate to the digestive capacities. Some easily-digested fat—particularly in cases in which there has been loss of flesh

[1] *L'Hygiène alimentaire*, p. 420.

—should soon be added; indeed, progress in blood-making will often fail to take place until some digestible fat be added to the dietary. A dessertspoonful of cod-liver oil once a day will frequently suffice, and should be ordered when it is not objected to. When this is objected to, some other form of fat should be introduced into the daily dietary. Butter is one of the best; so is cream. They may be agreeably mixed with some farinaceous food in the form of light puddings and served with fruit-sauce or jelly. Broiled fat bacon at breakfast is, with many persons, an easily-digested form of fat.

Eggs in any form, especially the yolks, are a very suitable food, as they present a concentrated and generally easily-digested form of nutriment rich in iron. The yolks of one or two eggs, beaten up with a little boiling water, with or without milk, to which a little sugar, nutmeg or other spice, and a tablespoonful of brandy may be added, is an excellent and nutritious restorative in those cases of anæmia with cardiac feebleness and loss of appetite.

Bauer[1] is decidedly in favor of a liberal proportion of nitrogenous food in the dietary of anæmic patients. "It is probable," he says, "that the reproduction of the most essential components of the blood, especially of the red corpuscles, would be greatly favored if relatively more albumin were contained in the food of such patients than is proper under physiological conditions."

The class of *fat* anæmic people—mostly women—are alluded to by Dr. S. Weir Mitchell as of the "utmost clinical interest." They are rare, as he remarks, and must be dependent on conditions not common to all anæmics. Those that we have seen have been apparently traceable to long-continued faults of diet, especially to the avoidance of nitrogenous food and the consumption of a vastly-increased proportion of carbohydrates.

One of the most remarkable cases of this kind we ever observed was in a patient who had a perfect mania for pastry-cooks' sweets. She spent large sums of money habitually at the pastry-cooks', and when any impediment was put in her way she would succeed, by all sorts of ingenious contrivances, in getting her usual supply of sweets. This enormous consumption of carbohydrates in combination with fat (as in pastry) was of course associated with entire indifference to animal food.

"Obesity with thin blood" is certainly, as Dr. Mitchell maintains, a "most unmanageable condition." The most useful treatment he believes to be a combination of an exclusively milk diet—well-skimmed milk—with rest and massage:

"In old cases of this kind the best plan is to put the patient at rest, to use massage, restrict the diet to skimmed milk or to milk and broth free from fat, and with them, when the weight has been sufficiently

[1] *Dietary of the Sick; Diet in Anæmia and Hydræmia*, p. 275.

lowered, to give iron freely, and, by degrees, a good general diet, under which the globules rise in number, so that even with a new gain in flesh there comes an equal gain in strength and comfort."

He gives as an example the case of a lady aged forty-five, who weighed 190 pounds, her height being 5 feet 4½ inches; she was also anæmic, feeble, and breathless.

"She was kept in bed five weeks. Massage was used at first once daily, and after a fortnight twice a day, while milk was given, and in a week made the exclusive diet. Her average of loss for thirty days was a pound a day, and the diet was varied by the addition of broth after the third week, so as to keep the reduction within safe limits. . . . . After two weeks I gave her the lactate of iron every three hours in full doses. In the fourth week additions were made to her diet-list, and Swedish movements were added to massage, which was applied but once a day; and during the fifth week she began to sit up and move about. Her weight at the seventh week had fallen to 145 lbs., and her appearance had decidedly improved. . . . . Now, after two years, she is a well and vigorous woman."

Forced Feeding ("*Alimentation forcée*" of the French).—Debove discovered, by accident, that in cases in which all food introduced into the stomach in the ordinary way was rejected by vomiting, strange to say, food introduced by the œsophageal tube was retained; and on this observation he founded his method of artificial "*suralimentation.*" He finds that he is able to introduce into the stomach by this means an "excess" of food which is retained and digested; and he truly observes that a person with phthisis requires considerably more food than a person in health, on account of the considerably greater bodily waste taking place. He has also observed that the digestive power of the patient has no relation to the appetite. "A patient who has no appetite, or who has a marked disgust for all food, will digest perfectly a large meal introduced by the tube, and even at the end of a certain time will recover appetite."[1]

As the results of *suralimentation*, or excess of food, he has observed disappearance of night-sweats, diminution and disappearance of cough and expectoration, increase of strength, rapid gain in weight, and at the same time a considerable amelioration in the physical signs.

By the use of powdered raw meat, Debove and Dujardin-Beaumetz in Paris, and Peiper in Griefswald, have been able to apply the principle of *suralimentation* without the necessity of using the œsophageal tube.

Dujardin-Beaumetz gives the following instructions for making this powder: Take the lean of beef, cut it up into small pieces, dry it in a water-bath; when thoroughly dried reduce it to powder in a coffee-

[1] *Leçons cliniques et thérapeutiques sur la Tuberculose parasitaire*, p. 82.

mill or by means of a machine constructed by Galante (No. 2, Rue de l'École de Médecine, Paris). This powder can be mixed with lentil flour and taken in the form of soup, or, better still, it may be mixed with chocolate or with grog—"*grog de la poudre de viande.*" To make the latter, place in a bowl two tablespoonfuls of meat powder; to this add three dessertspoonfuls of "syrup of punch" (essence of rum punch), and enough milk to make a perfectly fluid mixture. By these means from 1500 to 6000 grains of meat powder can be given daily;[1] the latter quantity would be equivalent to 24,000 grains, or three and a half pounds of raw meat. Or it may be given, as recommended by Debove, simply mixed with milk, first adding just enough milk to make a smooth paste, and then mixing in the remainder, so as to make a uniform fluid mixture that can be readily drunk. It is necessary in using these powders to see that they are genuine and not over-dried.

Since the adoption of powdered raw meat for *suralimentation* the introduction of food into the stomach by means of the œsophageal tube is reserved for those cases in which, owing to irritability of the gastric mucous membrane, food taken in the ordinary way cannot be retained in the stomach.

Special Dietetic Cures.—(*a*) *The Milk and Whey Cures.*—The so-called "milk cure" has been systematically applied to the treatment of many chronic maladies. Karell, of St. Petersburg, has been one of the chief advocates of an exclusively milk diet in certain diseases, and S. Weir Mitchell has to some extent adopted his views and extended their application.

The following are the diseases in the treatment of which an exclusively milk diet has been found of value: Dropsies of all kinds, cardiac, renal, and hepatic; obstinate intestinal neuralgias; incorrigible dyspepsias with grave disturbances of nutrition; hepatic disorders, such as hyperæmia, simple hypertrophy, and fatty liver; asthma, when the consequence of pulmonary catarrh and emphysema; hysterical and hypochondriacal states associated with serious disturbances of nutrition; and especially in disorders of nutrition dependent on latent catarrhs of the stomach and intestine.

Karell considers that the methodical application of his milk cure produces its curative effects by acting as a *regulator of nutrition;* and he maintains that it is highly beneficial, not only in the cases already enumerated, but also in rheumatic and gouty affections, in organic diseases of the heart and advanced renal degeneration, and especially in degeneration of the arteries.

Both Karell and Mitchell direct that the milk used should be *well skimmed,* and as creamless as possible, and it should be obtained fresh

[1] Dujardin-Beaumetz: *L'Hygiène alimentaire,* Paris, 1887.

twice daily from country-fed cows. They also agree that at first the doses should be small. Mitchell prescribes 4 ounces every two hours, and as the dose is increased the interval between the doses is lengthened to three hours: he also allows a glass during the night, to which a little lime-water is added to keep it sweet.

Karell commences with from 3 ounces to 6 ounces three or four times a day. He insists on the doses being rigorously fixed and scrupulously adhered to, and that no other food be taken. The doses should be taken at equal intervals, and drunk slowly in small mouthfuls, so that the saliva may mix with it. Taken in this way it will be readily digested, whereas drunk *ad libitum* it would cause indigestion. In winter the milk should be warmed by standing the glass in hot water; in summer it should be of the temperature of the apartment. It should not be boiled except in rare cases of diarrhœa.

If the milk is well digested, as indicated by small solid motions, the dose is slowly increased. The first week is the difficult one to get over; during the second week two bottles a day may be taken at fixed intervals—viz. 8 A. M., 12 noon, 4 P. M., and 8 P. M. These hours may be changed, but the intervals must be maintained.

When there is great objection on the part of the patient to its use, with nausea or disgust, Weir Mitchell allows it to be flavored with a little tea, coffee, caramel, or salt. He also advises in certain cases that the general diet should be displaced slowly until the exclusive milk diet can be tolerated. When it provokes acidity some alkali may be added, such as lime-water or Vichy water, or it may be scalded with boiling water and a little carbonate of sodium, and salt added, or a little barley- or rice-water may be mixed with the milk to prevent firm clotting.

Karell asserts that although he commences with such small doses, the patients never complain of either hunger or thirst; and he adds that if patients who are seriously ill attempt to take, instead of the four cups of skimmed milk, four large glasses of milk direct from the cow, they will certainly not be able to digest it, and the treatment will be discredited. In obstinate sickness and diarrhœa he has obtained the best results from these small doses, and he cites one such case in which he gave only four tablespoonfuls of skimmed milk three times a day. No doubt in a case of this kind the almost absolute rest of the digestive organs which such treatment affords is an important agent in the cure.

Constipation he considers a natural consequence and a good sign—a sign that the milk is absorbed. It may be remedied by a simple enema of water or by a small dose of castor oil or rhubarb, and if obstinate a little coffee should be mixed with the morning milk, or some stewed prunes or a baked apple may be eaten at 4 P. M.

Flatulence is, as a rule, completely relieved by this diet; if, how-

ever, any flatulence or diarrhœa should be complained of, it is owing either to imperfect skimming of the milk or to its being taken in too large a quantity. Thirst may be relieved by simple water or seltzer-water.

If during the second or third week there should be a great desire for solid food, a little stale bread with salt or a small portion of a salted herring is permitted; and once a day a little soup made with milk and thickened with groats. After five or six weeks some modification is admissible; milk, however, should still be taken three times a day, and some other suitable food at dinner.

Mitchell allows Nestlé's or some other similar food to be substituted as the case progresses. To objectors Karell says: "Milk is a food easy of digestion for everybody, provided it is given with precaution in strictly measured doses and is of good quality." He states that he has obtained excellent results in desperate cases in which other remedies had proved useless, and especially in chronic gastric and intestinal disorders.

Mitchell points out the importance of combining rest with this treatment at the commencement, as the patients lose weight at first and feel weak on account of the small amount taken; after long use, however, they increase in weight. For the first week or two it also causes sleepiness. The tongue becomes covered with a white, thick fur, and the patients complain of an unpleasant sweetish taste in the mouth on waking. The stools are of a yellowish color and have a peculiar odor. There is usually a large flow of urine,[1] which may exceed in quantity the fluid ingested, and so lead to the removal of dropsical effusions. Weir Mitchell has also observed that uric acid disappears almost entirely from the urine, which assumes "a singular greenish tint," and when hot nitric acid is poured upon it, it no longer gives the usual mahogany tint at the plane of contact, and it would seem that during a diet of milk "the ordinary pigments of the urine disappear or are singularly modified." The substances which give rise to the ordinary fæcal odors also disappear.

"The changes here pointed out are remarkable indications of the vast alterations in assimilation and in the destruction of tissues which seem to take place under the influence of this peculiar diet." [2]

The Whey Cure.—In many of the German and Swiss spas, and especially in those with alkaline and salt springs, where chronic catarrh of the respiratory organs is treated, such as Ems, Ischl, Reichenhall, etc., the so-called "whey cure" is applied. This consists in drinking warm whey, either alone or mixed with the mineral water, in definite

[1] It has recently been stated by G. Sée and Dujardin-Beaumetz that *lactose* alone acts as a powerful diuretic.

[2] *Fat and Blood*, 5th ed. p. 103.

quantities, at set times. Many physicians regard this practice as in all respects similar to the use of skimmed milk, and in no respect preferable except in persons who find the casein of milk indigestible. About 20 ounces daily are taken.

It relieves irritable laryngeal coughs and exercises a favorable influence over chronic laryngeal and bronchial catarrhs. It has been found useful in certain forms of dyspepsia and in chronic phthisis. It acts also as a diuretic, especially in combination with the saline mineral waters, and recent observations have shown that *lactose* possesses distinctly diuretic properties.

The "whey cure" is not an exclusive diet cure, but it is usual to limit strictly the quantity of animal food taken and to augment the amount of fruit and vegetables; it adds, however, to the diet a certain amount of milk-salts and milk-sugar. At the health-resorts mentioned whey is prepared from the milk of the sheep and the goat, as well as from cow's milk.

There are various methods of preparing whey. When an acid or when rennet is added to milk, the casein coagulates and forms the so-called *curd* of milk, and the fluid from which it separates is termed *whey*.

Rennet coagulates milk with an alkaline reaction, and forms what is called "sweet whey." In this process the casein is decomposed into the precipitated cheese and the slightly soluble whey-albumin.

The whey contains some soluble albumin and fat, and a great proportion of the salts and lactose, together with some lactic acid.

Whey, though not very nutritious, is an exceedingly useful fluid food when milk cannot be digested. As it is also a pleasant beverage, it can be given freely, and so a considerable amount of nutritive substance may in this manner be administered. It can be made with lemon-juice, or white vinegar, or white wine, or cream of tartar, or alum, as well as with rennet.

The following is Dr. Louis Starr's method of preparing whey, and this produces a more nutritious beverage than the ordinary mode of preparing it: Take half a pint of fresh milk heated to about 140° or 150° F., and 1½ teaspoonfuls of wine of pepsin or one teaspoonful of Parke, Davis and Co.'s pepsin cordial, and stir just enough to mix. Let the mixture stand in a warm place until firm coagulation has taken place. Next beat up the curd until it is finely divided, and strain. Whey thus prepared not only contains in solution the sugar and the salts of the milk, but holds also in suspension a considerable portion of casein and fat, which passes through the strainer.

The Koumiss Cure.—*Koumiss*, the fermented milk of the steppe mares, is used as a food and as an intoxicating beverage by all the nomadic tribes of the south-eastern steppe country of Russia. But it

is as a *systematic cure* in various maladies that we now refer to it. It is on the steppes themselves that the best koumiss and the best results of the koumiss treatment are obtained—although at Moscow and St. Petersburg institutions exist for the application of this cure—and where koumiss prepared from steppe mares is employed. A specially selected breed of mares yields the milk made use of. The summer climate of the steppes seems to be especially favorable to the treatment of pulmonary complaints, but the winters are extremely severe. The nomads appear to possess the art of making koumiss in the greatest perfection, but its composition is by no means stable. It is comparatively rich in sugar and poor in casein and fat.

Large quantities of koumiss can be easily digested, and it has been observed to exert a diaphoretic or a diuretic action according as the external temperature is high or low. Its use is constantly attended by a gain in weight.

Many cases of phthisis are reported to have been cured by this treatment when followed on the steppes of Orenberg or Ssamara, where, doubtless, the dry climate has also a curative influence.

The best koumiss is made from the milk of light-colored unbroken mares pasturing on the steppes near mountain-ranges, where they can get running water and salt-beds. They should be able to bathe frequently, and they must not have either hay or oats.

Two kinds are there prepared—one light and slightly fermented, the other strong and highly fermented.

The patients are made to rise early and take a glass of koumiss every half hour, except during the two hours preceding dinner and supper. Meat and fats form the chief part of the ordinary food; sweets, fruit, and salads are avoided, as well as ices, coffee, and spirits. Lime-water is used to arrest the diarrhœa koumiss often causes. At first a few glasses only are taken daily, so as to accustom the patient gradually to the cure.

Most invalids digest it well; it relieves constipation and acts as a diuretic. They gain in weight and show signs of increased blood-formation. Tent-life and much exercise in the open air are no doubt important adjuncts to the cure.

Annaeff's and Postnikoff's establishments at Ssamara are the best places for following this cure.

Good koumiss is a milky-looking, frothy liquid, with an agreeable slightly acid taste. It contains 1 per cent. of alcohol and lactic acid. Its ready digestibility has been referred to the alcohol in it stimulating the digestive secretions, and the carbonic acid allaying gastric irritability.

The proportion of alcohol in koumiss is too small to produce any symptoms of intoxication, but a tendency to sleep and to mental and

bodily languor has been noticed to follow its use. Excitement of the sexual organs has also been noted by several observers to follow the use of koumiss.

The treatment on the steppes lasts two or three months, and is often renewed the following summer.

Annaeff's establishment stands in a park on a hill on the banks of the Volga, three versts distant from Ssamara. It is provided with a library, theatre, and other comforts. The koumiss is prepared by a Tartar family in the sight of the patients and with due regard to cleanliness. In its manufacture the milk-sugar is converted into alcohol, carbonic acid, and lactic acid. The casein is in a state of fine subdivision most easy of digestion.

An analysis of koumiss, made in Moscow after two days' fermentation, gave—alcohol, 1.65 per cent.; fat, 2.05; milk-sugar, 2.20; lactic acid, 1.15; finely-divided casein, 1.12; salts, 0.28; carbonic acid, 0.70. Dr. Stange came to the conclusion that "favorable results can only be obtained from the koumiss cure on the steppes, since, besides the employment of a genuine koumiss, a hot and dry climate is absolutely necessary;" that it is especially beneficial in catarrhal conditions of the respiratory and gastric mucous membrane; that it is often successful in the first stage of phthisis; that in the second stage it simply improves the general condition, and in the third stage is badly borne; and that it is especially curative in cases of defective nutrition generally —cases of anæmia, chlorosis, malarial cachexia, scrofula, etc.

Artificial koumiss is prepared in Europe, largely from cow's milk. The cows should be fed in open pastures, and special means are adopted to diminish the relative amount of casein and increase the relative amount of sugar contained in cow's milk. It must be regarded as a food intermediate in character between milk and alcohol—more stimulating than the former, more tonic than the latter. Unfortunately, many persons cannot overcome their dislike to it as a beverage. When it is well borne it is found to be easy of digestion, often relieving dyspepsia and vomiting and producing increase of weight. It is appropriate to febrile cases, as it quenches thirst, and can often be retained in the stomach when all other food is rejected; indeed, its especial value is in those cases of inveterate dyspepsia and gastric irritability in which all attempts to give other kinds of food have failed.

Kefyr is another fermented drink, prepared in the mountains of the Caucasus from cow's milk. This fermentation is brought about through the agency of a micro-organism, the *Dispora caucasica*, which is added to the milk, and which possesses the property of converting the lactose into alcohol and carbonic acid.

As cow's milk contains proportionately much less sugar than mare's milk, kefyr therefore contains less alcohol than koumiss.

The Grape Cure.—This is another dietetic cure which must here be briefly described.

The nutritive value of grapes is not great; they, however, contain much sugar as well as potash salts. They are an agreeable form of food, and afford one of the few means at our disposal between nutritive substances on the one hand and medicinal substances on the other. Much of the benefit referred to this cure may doubtless be attributed to the climatic advantages presented by those agreeable localities, such as Meran and Montreux, where it is usually followed.

Professor Lebert speaks of the grape cure as essentially a dietetic cure, notwithstanding its refreshing and aperient effects; and he is quite opposed to the consumption of very large quantities, as has been advised by some authorities, and considers that only moderate quantities should be prescribed. The effect of the cure is aided by a good supporting diet. Patients with pulmonary disease should not take more than an average of 2 pounds daily, beginning with about a pound, and other patients should not exceed 4 pounds. In cases of gastric catarrh 3 pounds a day may be eaten, the diet at the same time being carefully regulated. Constipation, with hepatic congestion and "abdominal plethora," may be benefited by from 3 to 4 pounds daily, and in these cases the dose may, exceptionally, be increased to 5 or 6 pounds. The laxative influence of from 4 to 6 pounds of grapes eaten daily has been found beneficial in hæmorrhoidal affections and in cardiac diseases with a tendency to visceral congestion and venous engorgments, in hyperæmia of the liver, and in chronic constipation.

The tendency to renal and hepatic concretions is often advantageously modified by this cure. Professor Lebert remarks, as the result of his own observations at Montreux, that the grape cure is very valuable "to those who are neither ill nor well, who are fatigued by a too exciting and somewhat intemperate life; or, weakened by severe illnesses, are convalescing slowly; or who, leading habitually a too sedentary and too laborious an existence, find in our country, besides the grapes which regulate the digestive functions, all those hygienic conditions which they most need. In this way the passage of debility and fatigue into real diseases may often be prevented." It is best to begin with half a pound of grapes in the morning fasting (or an hour or two after a light breakfast if they disagree when taken fasting), and another half pound at 5 P. M. After two or three days a third half pound should be taken between 11 o'clock and noon. Little by little the dose is increased to about a pound each time. In cases of pulmonary disease Lebert rarely exceeded the smaller quantity. In other cases which bear the cure well larger quantities may be prescribed. In some cases of dyspepsia a bunch or two at dessert may be substituted for the midday dose.

The aperient effect may not be manifest at first, but usually shows itself after a few days.

At Meran figs and pears are also permitted with the cure in order to diminish the repugnance to one kind of fruit alone.

Some irritation of the gums is apt to be excited during the cure; this may be relieved by rinsing the mouth with cold water to which a little bicarbonate of sodium is added. It has also been recommended that the patient should take while eating the grapes, from time to time, a small piece of fine white bread to remove the acid adhering to the teeth.

Toward the end of the cure, which lasts from four to six weeks, the quantity should be gradually diminished.

The mean composition of grapes, according to König, is—water, 78.17 per cent.; sugar, 14.36; free acid, 0.79; nitrogenous substances, 0.59; non-nitrogenous extractives, 1.96; stones and woody fibre, 3.60; total ash, 0.53. The ash consists chiefly of potassium salts, together with salts of lime and magnesium.

We have already indicated certain cases in which the grape cure may prove beneficial. It is also prescribed with success in those cases of "abdominal plethora" associated with a deposition of much superfluous fat; much of this fat may be removed if the laxative influence of the grapes is aided by a spare diet in which the fats and carbohydrates are strictly limited. It cannot be credited with any real curative influence in phthisis, but it appears to be useful in cases of chronic bronchial catarrh and emphysema; and it may no doubt relieve the bronchial catarrh which accompanies most cases of phthisis.

It has been found beneficial in cases of gastric and intestinal catarrh, in anæmic persons, in vesical catarrh, in gouty concretions, and in cases of malarial cachexia.

Artificial Digestive Agents and Predigested Foods.

The chief of those digestive agents which now form an important valuable addition to the therapeutic resources of the physician are (*a*) *Malt extracts;* (*b*) *Pepsin* and its preparations; (*c*) *Pancreatin* and the preparations into which it enters.

(*a*) **Malt Extracts and Malted Foods.**—These are simply predigested starches, together with other nutritive substances, and it must not be concluded that they can supplement or reinforce the pancreatic digestion of starch *in the small intestine*, for the amylolytic ferments are wholly inactive in the presence of free acid, and the salivary (diastasic) ferment is under ordinary conditions destroyed in the stomach. The diastase of malt, like the salivary ferment, exerts its amylolytic action most energetically in a neutral fluid; the addition of an alkaline carbonate retards it, while a very slight amount of acid

(such as the hydrochloric acid of the gastric juice) puts a stop to it. In the feeding of very young infants who cannot digest milk, and who, as we have seen, naturally lack the salivary and pancreatic secretions, when malted foods are used it is for the purpose of supplying predigested starch, which they are unable to digest from the lack of these ferments. It is possible that we might in old subjects convey the diastasic ferment safely through the stomach into the small intestine, if we desired to, by previously neutralizing the acid of the stomach by giving a little carbonate of lime or magnesium ; but we should then be interfering with the action of one digestive ferment in order to reinforce that of another.

The diastasic power of malt extracts has been found inferior to that of ground malt itself, and these, as we have said, must be regarded rather as preparations of soluble foods than as digestive agents. They contain, besides the diastase of the malt and predigested starch (dextrin and maltose), some of the albuminates and salts of the barley. Like ground malt, when added to farinaceous foods and kept at a temperature below 150° F. they promote the transformation of the starches into dextrin and sugar; but it is an error, as we have just pointed out, to suppose that they continue this amylolytic action when taken into the stomach.

Many varieties of "malted foods" are now in common use, but "Liebig's Infants' Food" may be taken as the prototype of all these. It contains ground malt, wheat flour, potassium bicarbonate, and milk, and it is directed to be made in the following manner:

Mix well $\frac{1}{2}$ an ounce of ground malt with $\frac{1}{2}$ an ounce of wheat flour and $7\frac{1}{4}$ grains of potassium bicarbonate; add 1 ounce of water and 5 ounces of fresh cow's milk. Warm over a slow fire, and keep stirring until it becomes thick. Remove from the fire, stir for five minutes, replace it on the fire, and remove it as soon as it gets thick. As the starch is converted into dextrin and sugar by the diastase of the malt, it will become a thin and sweet liquid. Then, finally, boil it well. Strain through muslin.

This food is highly nutritious; besides the constituents of the milk, it contains predigested starch (dextrin and maltose) and the albuminates (gluten and albumin) of the wheat flour and the malted barley.

Foods composed (as some malted foods are) of malted flour and desiccated milk when mixed with water are defective as the sole food for children, as they do not contain the adequate proportion of fats, proteids, and salts; but these can be readily increased by the addition of a little cream or rich milk or some raw meat-juice. In preparing the various malted foods it is usual to bake the wheat flour, so as to render the starch-granules more soluble.

Mellin's and Nestlé's infant foods are examples of these malted preparations.

Pepsin, the proteolytic ferment of the gastric juice, acts only when in combination with an acid, and preferably hydrochloric acid. In contact with a dilute solution of sodium carbonate at the temperature of the body it is quickly destroyed, and it is also quickly destroyed by the alkaline secretions of the small intestine, aided by the action of the pancreatic ferment, trypsin.

Pepsin is rarely used for the preparation of artificial peptones or predigested foods, but it is largely given to promote the activity of stomach digestion in the stomach itself.

For this purpose many excellent preparations exist, but some are very uncertain and many probably quite inert.

Professor Chittenden of Yale University found the following remarkable differences in the proteolytic power of different pepsins:[1]

	Relative proteolytic action.
1. Parke, Davis & Co.'s Pepsinum Purum in Lamellis	100
2. Fairchild's Pepsin in Scales	52
3. Scheffer's Dry Pepsin Concentrated	48
4. Jensen's Crystal Pepsin	35
5. Boudault's Pepsin	14
6. Royal Chemical Company's Pure Pepsin	9

Pancreatin and Peptonized Foods.—We must again point out that the value of these preparations depend on their being *predigested* foods, and it would be an error to suppose that in administering them we are introducing an active digestive ferment into the small intestine; for the proteolytic action of trypsin is arrested in an acid medium like the gastric juice, and the gastric pepsin aids in the destruction of the ferment. "Hence, it is obvious that pancreatic extracts or ferments given by the mouth can be of no value whatever, since the proteolytic ferment at least will undoubtedly be destroyed in the stomach before reaching its normal sphere of action."[2]

If, however, as seems possible, the pancreatic extracts could be administered in capsules composed of a substance insoluble in dilute acid, but soluble in alkaline fluids, and be so conveyed unharmed through the stomach to the duodenum, the difficulty would be overcome. *Keratin* appears to be a substance of this kind. Trypsin acts best in an alkaline medium, and pancreatic extracts are usually mixed with an alkali, but it is also active in a neutral medium.

Peptonized foods, strictly speaking, are artificially-digested albuminates, and might be made with pepsin and hydrochloric acid, as well as with pancreatic extract; but the latter is usually used, and when

[1] *The Medical News*, Feb. 16, 1889.

[2] Prof. Chittenden on "Digestive Ferments," *The Medical News*, Feb. 16, 1889.

applied to foods containing carbohydrates or fats, as well as albuminates, its amylolytic and emulsifying properties also come into operation, and we obtain a very completely predigested food.

Pancreatin and the pancreatic peptones decompose very readily, and for this reason it is important in using them to be careful that no poisonous ferments are thereby introduced into the organism.

Meat-peptones are no doubt highly nutritious, but they are often of an unpleasant taste and odor: the smell of pure muscle-peptone is said by Zuntz to be very objectionable, and the more agreeably flavored preparations are said by Dujardin-Beaumetz to contain much comparatively useless gelatin-peptone.

This unpleasant odor and taste undoubtedly detracts from the administration of meat-peptones by the mouth, but it does not interfere with their employment in rectal alimentation, for which they are very valuable.

But many peptonized foods can be conveniently made for the sick-room as required by means of pancreatic extracts now readily obtainable.

The best of these are Benger's liquor pancreaticus, Benger's peptonizing powders, and Fairchild's *zymine*, a very convenient and active pancreatic extract introduced by Messrs. Burroughs & Wellcome, and supplied in air-tight glass tubes, each containing the exact quantity of pancreatic extract (5 grains) and sodium bicarbonate (15 grains) required to peptonize one pint of milk.

These pancreatin powders are very hygroscopic, and it is important that they should be kept in air-tight glass tubes.

Milk can be readily peptonized by these pancreatic extracts; the casein is converted into soluble peptones, and it thus becomes a most valuable food for delicate infants and others who cannot digest the coagulated casein of cow's milk. If, however, the milk be *completely* peptonized, it acquires a bitter taste which renders it unpleasant, and children will object to taking it; but if, as we shall describe, the process of peptonization be arrested at the proper time, and the milk be only partially peptonized (which, for other reasons, is an advantage), no disagreeable bitter taste is developed.

The method of peptonizing milk by means of Fairchild's peptonizing powders is very simple:

Into a clean quart bottle pour a pint of milk, add a quarter of a pint of water and a tube of Fairchild's powder; shake them together. Put the bottle into water as hot as the hand can bear (about 150° F.), and let it stand for half an hour; then boil for two or three minutes.

It is then ready for use. It should be kept on ice or freshly made for each feeding. Boiling is for the purpose of permanently arresting the action of the ferment; cold will arrest it temporarily, and if kept covered with ice it is not necessary to boil it.

If the milk be allowed to stand longer than half an hour, peptonization will proceed too far and undesirable bitter products will be generated.

We can regulate the peptonization to any degree required, and we should be guided by the readiness with which the food is assimilated by the patient. For young bottle-fed infants a very slight degree of peptonization is often all that is required.

A teaspoonful or two of Benger's liquor pancreaticus and 15 grains of bicarbonate of sodium will answer equally well. The more completely we desire the food to be peptonized, the more, proportionately, of the digestive agent should be employed and the longer the process allowed to continue.

Peptonized milk gruel is also an excellent and valuable predigested food, highly commended by Sir William Roberts. It can be made as follows: A good thick gruel made with oatmeal or other meal, while still boiling hot, is added to an equal quantity of cold milk. The temperature of the mixture will then be about 140° F. To a pint of this mixture two or three teaspoonfuls of liquor pancreaticus and twenty grains of bicarbonate of sodium are added. It is kept at the same temperature for about two hours, and then boiled for a few minutes and strained.

In this mixture not only is the casein of the milk peptonized, but the starch of the meal is converted into sugar and its albuminates are peptonized.

The bitterness of the predigested milk is scarcely perceptible in this gruel.

Lean meat can also be readily peptonized by means of Fairchild's pancreatic extract or Benger's liquor pancreaticus:

If 4 ounces of finely-minced lean meat be added to half a pint of water, and then gradually brought to a boil, then half a pint of cold water added so as to reduce the temperature to about 140° F., and then thirty grains of Fairchild's zymine and twenty grains of sodium bicarbonate added, and the mixture kept warm for about three hours, the meat will be peptonized.

Peptonized beef-tea can be made in the following manner: Take half a pound of finely-minced lean beef; add to it a pint of cold water, and cook over a gentle fire till it boils. Decant the beef-tea into a jar or bottle, rub the meat into a paste, add it to the beef-tea, and mix in another pint of water to reduce the temperature to about 140° F. Add a tablespoonful of liquor pancreaticus or sixty grains of Fairchild's pancreatic extract and twenty grains of sodium bicarbonate. Stand in a warm place for three hours, shaking occasionally; then boil quickly for two or three minutes, and strain.

This is a weak beef-tea, but it can be made of any strength required.

Rectal Feeding.

It has been ascertained experimentally that soluble albumin, such as is contained in expressed meat-juice, is absorbed in the rectum to nearly the same extent as complete peptones; also that starch is converted into sugar and absorbed in considerable quantity; egg-albumin, when mixed with a small quantity of common salt, is also absorbed, but the mixture is too irritating to be suitable for enemata. Fat in emulsion also appears to be absorbed in the rectum. Solutions of peptones appear to be absorbed readily, but they must not be too concentrated or they prove irritating to the mucous membrane of the rectum, and they are then not retained. Expressed meat-juice and peptones seem, then, the most suitable foods for rectal alimentation. According to Bauer's observations, under no circumstances can more than *a fourth part* of the amount of nourishment necessary for subsistence be absorbed in the rectum from nutrient enemata, as its capacity is limited and the absorption of nutrient matters therein exceedingly slow.

Leube has pointed out the importance, if nutrient enemata are to be used for any length of time, of only employing substances that cannot cause the least irritation of the mucous membrane of the rectum, and that can be prepared without any great difficulty; and he has suggested enemata of meat and pancreas made in the following manner: Mince fine from 150 to 300 grammes of meat, and mix with from 50 to 100 grammes of finely-chopped pancreas, free from fat. Beat the mixture into a paste with a pestle or spoon, adding a little lukewarm water to make it of a suitable consistence for injection through the enema-tube. Use warm; if cold, it may excite the rectum and cause expulsion. If thought desirable, from 25 to 50 grammes of fat may be intimately mixed with the mass by the help of a warmed pestle. A syringe with a wide nozzle must be used. Such enemata cause no irritation of the mucous membrane of the rectum, and can be retained from twelve to thirty-six hours. Evidence was also obtained by Leube that a considerable portion of the albumin and fat of such enemata is absorbed.

Peptonized milk gruel or peptonized beef-tea, mixed with some soluble carbohydrates, such as maltine or a mixture of one of the malted foods and peptonized milk, are useful preparations for rectal alimentation. Small quantities of wine or brandy may be added to such enemata when stimulation is indicated.

It is advisable to wash out the rectum with pure water an hour before administering a nutrient enema. Only a small quantity should be injected at a time—from 1 ounce to 3 ounces; a larger quantity is liable to be rejected. The tube should be well oiled to avoid setting up soreness or irritation at the anus, and it is well to use a long one, so as to inject the fluid as high up as possible, in order that it may come

in contact with a more extensive absorbing surface. The addition of opium to the injection may ensure retention, but it may also retard absorption.

Peptonized suppositories are also prepared containing peptonized concentrated milk or meat, together with digested oil. These are said to have sustained life for weeks without exciting any rectal irritation. We have seen that it is impossible to maintain life for any length of time simply by rectal alimentation. If we have to trust to this alone, we can only avert death from starvation for a brief time, probably for two or three weeks. Not only is the amount of nutriment that can be absorbed by the rectum insufficient for the maintenance of life, but diarrhœa is extremely liable to set in after a time, so that the rectal injections are no longer retained.

As a temporary expedient it is exceedingly useful in all those cases in which there exists a mechanical impediment to the reception of food in the natural way; if this is not permanent, it may afford time for its removal, but if it is permanent it can only prolong life for a few weeks.

Rectal feeding is also a useful resource in certain states of the digestive organs in which they are intolerant of the presence of food, and in which it is desirable they should for a time be kept at rest—in cases of obstinate vomiting, of gastric ulcer, of acute gastritis, of diphtheritic paralysis, of spasmodic or other stricture of the œsophagus, as well as in the exhaustion of fevers, in delirium, and in other conditions which it is not necessary here to enumerate.

GENERAL EXERCISE.

By EDWARD MUSSEY HARTWELL, Ph. D., M. D.

All remedial measures which are not blindly traditional are of necessity based upon and prompted by physiological conceptions. The fundamental conception of modern physiology regards the living body as a physical mechanism "whose proper working," to borrow Huxley's words, "we term health; its disturbance, disease; its stoppage, death." It is therefore not surprising that therapeutical measures should become somewhat more direct and mechanical in their character as our knowledge of the nature and course of the various activities and perturbations of the body is extended and rendered more and more precise. Surgery is now coequal with medicine, its base mechanical origin being no longer remembered against it. Hydrotherapy having been rescued, in a measure, from the control of laymen, has, at least in Europe, been accorded a corner in the domains of legitimate medicine. The emancipation of mechano-therapy, which of old stood above surgery, and on a par, to say the least, with hydrotherapy, is of more recent date, and has been less complete, especially among English-speaking peoples.

The term mechano-therapy and the class of procedures denoted by it are so uncommon, or little thought of, in the British Isles and America as to be practically neglected in the dictionaries of Dunglison and Quain. The term "mechano-therapy" has, however, the sanction of foreign usage, and is defined in the *National Medical Dictionary* of Billings as "the treatment of disease by mechanical means, such as massage, exercise, etc." We may use the term, then, to denote medical gymnastics or exercise and massage, though some writers employ it to denote massage alone.

The ends of exercise are essentially the same whether it be employed for recreative, hygienic, educational, or purely remedial purposes. To make rational and proper use of it, for any of the purposes named above, one must have a clear conception of the physiological principles of exercise, to begin with. It behooves us, then, at the outset, to consider somewhat closely the nature and effects of exercise.

It is interesting to note that our word exercise, and *exercitus* the Latin word for the body of best-trained men in the state, the army,

are derived from the same verb, *exerceo*. The Greek synonym for *exerceo* is *ἀσκέω*, and meant originally to work raw material. In classic times it meant to exercise, to train in the strict athletic or gymnastic sense; later, in the early days of the Church, it signified to discipline the flesh, to mortify the body, and to it in this sense the English word "ascetic" owes its origin and present meaning. The original ascetic was simply an industrious and careful gymnast or athlete.

The best comprehensive definition of exercise, that has come under my notice, is that given by the late Du Bois Reymond, professor of physiology in the University of Berlin. "By exercise we commonly understand," he says, "the frequent repetition of a more or less complicated action of the body with the co-operation of the mind, or of an action of the mind alone for the purpose of being able to perform it better." Practically, all human actions are comprised under the two heads of this definition of exercise. Bodily actions demand our chief consideration.

It is far easier to underrate than to exaggerate the part which muscular actions play in human life. Imagine the condition of a man perfectly formed, generously endowed, and in his prime, whose single lack should be that sensible warm motion that has its seat in the muscular tissue. The position of a fly in amber would be lively and preferable to the isolation of such a man. Of course he could not "do business," but he could think and fear and hope. He must face the future, lying like a log in whatever position he may happen to fall. His face will be absolutely destitute of expression, and his eyes fixed under closed lids. He can neither smile nor weep. His hunger cannot be appeased nor his thirst slaked. His heart may "burn within him," but it shall not pump blood, so that he will be pulseless as well as breathless and bereft of speech. Unable to stir the tip of a finger or to raise a hair, he will be powerless to express his thought or aspiration, or to impress his conceptions or wishes upon any creature. In short, such a man would be an incorruptible cadaver.

Without muscular tissue, then, we cannot live or move. Its importance to the body is also to be inferred from its mass and weight. Nearly, if not quite, one-half of the human body, by weight, is made up of so-called voluntary muscles. The skeletal muscles, moreover, are estimated to contain one-quarter of the blood in the body; and it is through their activity that a large portion of the potential energy of the body is turned into work and heat.

A freshly-dissected skeletal muscle of one of the higher animals presents a smooth surface, rounded outlines, and a glistening appearance, due to its sheath of connective tissue. Inward prolongations of this sheath pass into the substance of the muscle, and divide it into

bundles of fibres, technically called fasciculi or packets. Each fasciculus consists of a number of fibres running parallel to one another. The fibres are separated from one another by connective tissue, just as the fasciculi are. The muscle-fibre or cell is the ultimate and essential anatomical element of muscular tissue. Each fibre consists of a soft, contractile, semifluid substance contained in a tubular sheath—the sarcolemma, which is transparent, tough, and elastic. Fibres vary in diameter from $\frac{1}{600}$ to $\frac{1}{100}$ of an inch, and are seldom longer than $1\frac{1}{2}$ inches. These fibres or cells are arranged in linear series and do not inosculate with each other. The amount of shortening in a contracting muscle is equal to the summated contractions of its individual fibres.

If we lay bare a muscle in a living animal, we may cause it to contract before our eyes, either by bringing a heated body close to it; by giving it a slight tap; by applying certain chemical substances to it, such as ammonia, lime-water, or a solution of common salt; or by giving it an electric shock.

When a muscle outside the body is acted upon suddenly by an appropriate stimulus, it quickly shortens, and then, if it has been loaded with a weight, rapidly returns to its former length. A weighted muscle outside the body, or one in the body which acts against resistance, does work every time it contracts. Its work is chiefly of the sort which physicists have named mechanical work, and is equal to the product obtained by multiplying the weight lifted by the distance through which it is lifted against the force of gravity. Its measure is expressed in foot-pounds. A muscle with no weight attached does no "work" when it contracts, nor does it do any work if it is loaded with a weight too heavy for it to lift. Of two muscles equal in cross-section, the longer can do more work; whereas if two muscles are of equal length, that which contains the greater number of parallel fibres will do more work than the other. It is estimated that a square centimetre of human muscle can just lift a little more than twenty pounds. Muscles are somewhat elastic, and in the body are slightly overstretched.

Besides its contractile substance, its tendons, and the sheaths which invest its fasciculi and fibres, every muscle has blood-vessels and nerves, whose functions must be considered before we can arrive at a clear understanding of muscular exercise. Muscle-arteries and veins usually lie alongside of each other in the connective tissue which surrounds the fasciculi, while their capillaries form a fine meshwork of vessels, lying between and upon the muscle-fibres, but without penetrating the sarcolemma of any fibre. Along with the blood-vessels, lymph-capillaries are found in the interstices of the connective-tissue sheaths of the muscle-fibres, and of the tendons also. The lymph in these spaces is derived by transudation from the blood-capillaries on the one hand, and from

the muscle-fibres on the other. The fibres are therefore bathed in lymph, and derive their food-supply from it by absorption through their tubular sheaths. From this state of things there results an inward and outward stream or interchange of material between the muscle-substance and the blood through the capillary wall, the lymph-spaces, and the sarcolemma.

The nerve-fibres found in the muscles are of two sorts: the white or medullated, which are distributed to the muscle-fibres; and the gray or non-medullated, which are distributed to the plain muscle-fibres contained in the muscle-arteries and veins. The motor nerve belonging to a muscle usually enters the muscle at its middle point. It then divides and subdivides into so many branches that every muscular fibre receives a nerve-fibre. Where the nerve-fibre pierces the sarcolemma the axis-cylinder spreads out, forming an eminence of protoplasm within the sarcolemma. This eminence is known as the "motorial end-plate." The branches of the axis-cylinder traverse this end-plate, and subdivide into fibrils which penetrate the contractile substance of the fibre. Only the axis-cylinder of the nerve passes within the sarcolemma, since the outer sheath of the nerve-fibre coalesces with the sarcolemma itself, and the medullary sheath ends at the sarcolemma.

We have, then, the contractile substance of the muscle-fibre connected with the irritable stimulus-generating and transmitting substance of a central nerve-cell, situated in the spinal cord or the brain, the connecting link being the axial fibre of the motor nerve, which is simply a portion of the nerve-cell's contents long drawn out in the form of a strand, until it reaches the muscle-fibre, where it spreads out to form the end-plate, and then subdivides into fibrils which penetrate the muscle-substance. What is true of a single muscle-fibre is true of all the fibres in a given muscle; and what is true of one voluntary muscle is true of the entire five hundred. Voluntary muscles have sensory as well as motor fibres. They are the channels for the impulses which give rise to muscular sensibility, and are connected with centrally-situated nerve-cells which minister to our muscle-sense — the sense, that is, which keeps us informed concerning the condition of the muscles and the extent to which they are contracted.

A single muscle, then, is to be considered as an aggregation of a vast number of contractile fibres arranged in myriads of linear series, which in turn are gathered into bundles, all of which, along with their accompanying nerve-fibres and nutrient blood-vessels, are supported and bound together by means of elastic connective tissue. The muscle, so made up, has its own special sheath, and is bound by its inelastic tendons to the bones which it is set apart to set in motion. Muscular contractions can be brought about through the direct applications of chemi-

cal, thermal, mechanical, or electrical stimuli to the muscle itself. If the nerve of a muscle be excited by pinching it, by beating it, by applying certain chemicals to it, or by electrifying it, the muscle is indirectly stimulated to contract by means of the motor impulses discharged into it through its motorial end-plate. The motor nerve may be stimulated at any part of its course. Again, the muscle may be set in action through stimulation of the centres whence its nerve-fibres emerge by any of the stimuli mentioned above. Normally, the muscle-centres are stimulated chiefly by "volitional" stimuli.

The effects of exercise upon a muscle and the parts connected with it next demand our attention. Immediately a muscle begins to contract, under whatever stimulus, the blood-stream passing through it becomes changed, both in respect of quantity and quality. The arterial twigs which ramify within it dilate; more blood is poured into the capillaries surrounding its fibres; more lymph passes to the muscle-substance; and the outgoing streams of lymph and blood, in the lymph-capillaries and veins respectively, are augmented.

The blood which enters the muscle is bright red in color, rich in oxygen, and poor in carbonic acid. That which leaves it is dark blue in color and of a higher temperature, richer in carbonic acid, and poorer in oxygen, and contains various products having an acid reaction, due to the chemical changes which take place in the food-material supplied to the muscle-substance, and in the muscle-substance itself. If the supply of arterial blood to a muscle is cut off or diminished, its irritability is lowered; that is, a stronger stimulus is necessary to make it contract. The same result follows, also, if it is fed with blood deprived of oxygen or otherwise poisoned, or if the muscle-vein is tied and the waste-products, normally drained off through the veins, are retained within the muscle. The irritability of a muscle is also lowered by prolonged stimulation, even when its in-going and out-going blood-streams are unobstructed. If these disturbed conditions do not persist until the muscle-fibres pass into the condition known as death-stiffening, the irritability of the muscle may be restored, either by sending fresh blood through it, by sending a stream of some indifferent fluid through it, or by ceasing to stimulate it.

In the first case, restoration is brought about through the renewal of its supply of food-material and oxygen; in the second, by clearing out the noxious waste-products; and in the third, by allowing it to rest a while. These, then, are the main conditions demanded for the health of a working muscle: A full supply of proper food and oxygen; unimpeded and sufficient drainage; and rest at due intervals. Given these three conditions in the body, and exercise of a muscle causes it to increase in size and weight, within certain limits, through the increased size and number of its fibres. Furthermore, a working muscle differs

from a resting muscle in that it is appreciably hotter; by the presence of a low murmur, called the muscle-sound, which is caused by the more rapid vibration of the particles of the slightly overstretched fibres; and on account of certain electrical peculiarities which it presents.

Mention should be made of the fact that a muscular contraction presents three phases—viz. the latent period, the phase of shortening and thickening, and the relaxation period, during which the muscle is returning to its original form. There is practically no change of bulk during the contraction of the mobile muscle-substance. The length of the different phases varies under various conditions. The contraction phase is the most important of the three. The causes which determine the character of the phase of relaxation have not been fully made out.

A muscle habituated to exercise can do more work, and do it better, than an unexercised muscle; and for two reasons: exercise makes the muscle larger, harder, stronger, and more enduring, improving it simply as a tool in all its structure; and, secondly, the muscle responds more quickly and completely to the stimuli which stir it up to work. In other words, the muscle becomes more obedient to its stimulators, the nerve-centres, through its better acquaintance with them. A muscle, then, is a neuro-muscular machine for developing power, for transforming the potential energy stored up in its substance and the blood brought to it into one or another form of the energy of motion.

If we consider a single muscle as a mechanism for developing energy of motion, it may be compared to a peculiarly-arranged collection of cartridges loaded with powder and connected by wires with a series of electrical batteries. Each muscle-fibre would, in that case, stand for a single cartridge, the shell of the cartridge being represented by the sarcolemma and contractile substance; the charge of powder by the unstable chemical compounds stored up or loosely held in the contractile substance; the wire from the battery by the motor nerve-fibre, and the cells of the battery by the cells of the nerve-centre; and the electric current by the nervous stimulus, which, passing along the axis-cylinder through the nerve-plate into the contractile substance, gives rise to the phenomena which signalize a muscular contraction.

When a cartridge is exploded chemical actions take place which result in the sudden formation of gas, accompanied by the development of light, heat, and sound, and the production of a residue of smoke and ashes. If the cartridge-shell be tight and tough, the motion of the molecules of the suddenly-formed gas will be communicated to its particles and the shell be shaken or moved from its position. By varying the construction and arrangement of the cartridges we may cause the liberated energy of the explosive to set projectiles in motion, to rend rocks, or to move parts of mountains. The results of chemical explosions in the muscle-cartridges are less

violent than those above noted, but they are sufficiently similar and well marked to be termed parallel to them. The potential energy of the muscle-fibres is transformed into the energy of motion through the decomposition of the chemically-unstable contents of the sarcolemma. Heat, sound, electrical changes, and mechanical motion are evolved. The mechanical arrangement of the parts of the muscle is such that the total motion of the mass of its fibres is communicated by the tendons of the muscle to the parts of the body with which it is connected. So long as the muscle-fibres are properly nourished, and not too severely stimulated, the muscle-cartridges may be said to reload and maintain themselves in a state of readinesss to go off on the receipt of stimuli from the central battery.

Muscles are more perfect power-machines than are steam-engines and rifled cannon, not only because they develop relatively more work out of the energy stored up in the substances on which their activity depends, but also because they are distinguished from all machines of human manufacture by the fact that they are self-improving machines; that is to say, they become tougher and stronger as structures through exercise, and at the same time more capable and adaptable functionally. Growth or increase in the size, and possibly the number, of its structural elements, and development, or increased facility in its functional activity, are the main effects of exercise upon a single muscle. The same is true of the muscular system as a whole. Exercise enlarges and strengthens it on the one hand, and renders it more responsive and discriminative as regards stimuli on the other.

Regarded as a structure, the human body is an aggregation of a vast number of living cells which are so grouped and connected that the organism constitutes a communal structure, a sort of federal union of tissues and organs. The body is also a machine for doing work. Among machines, it resembles an army rather than such contrivances as an eight-day clock or a windmill. "Of this army," says Huxley, "each cell is a soldier, an organ a brigade, the central nervous system the headquarters and field telegraph, the alimentary and circulatory systems the commissariat."

In classifying the cell aggregation of the body—*i. e.*, its tissues and organs—we may arrange them in three great classes: I. Those which subserve the metamorphosis of material to be utilized in the growth and repair of the individual organism and in the continuance of the species. They include what may be characterized broadly as the digestive and the reproductive organs. II. Those which are chiefly instrumental in the transformation and expenditure of energy. III. Indifferent and supportive tissues and organs—*e. g.*, connective, cartilaginous, and bony tissues, found in the organs classified under I. and II.

For the sake of further simplicity, we may disregard the reproductive tissues belonging to Class I. and the whole of Class III., and say of the tissues and organs belonging to Class I. that they are concerned in renewing the substance of the body or in replenishing the body's fund of energy; and that the organs and tissues in Class II. are concerned in setting energy free.

Under I. we may place: (1) The tissues of digestion, or the "purveyor tissues," whose office it is so to prepare raw food or energy-yielding material as to bring it to the energy-expending tissues—*i. e.*, the muscular and nervous tissues—that they may build the prepared food into their own substance as easily as possible; and (2) The tissues of excretion, or "scavenger tissues," whose office it is to receive the waste matters which arise in the nervous and muscular tissues and prepare these substances for rapid and easy ejection from the body.

Under II. are placed the "master tissues," as Foster happily terms the muscular and nervous tissues, on account of the prominent part they play in liberating energy and turning it to account. Nervous tissue is the "masterful tissue" *par excellence*, and is served in one or another way by all the other tissues just mentioned.

Again, the bodily organs are divisible into: (1) Somatic, or primary, whose effectual working is requisite for the more general needs of the whole organism—*e. g.*, the digestive, circulatory, and excretory organs, the skeleton and the principal skeletal muscles, and the bulk of the brain and nervous system; and (2) Minor, or secondary, organs, as the organs of speech, the hands, and the more highly specialized parts of the brain and nervous system.

In contradistinction to the brute, man—thanks to his more complicated structure and more highly specialized functions—has a relatively larger "live capital" of free energy that can be turned into special forms of mechanical work. In comparison with savages and barbarians, civilized men have a larger fund of such capital at command, together with greater aptitude for expending it wisely and economically; while among civilized men the educated man, by reason of his superior training, is able to do more and better work than the ignorant adult or the youth in process of being educated. From our present standpoint, the main end of education appears to be to develop as fully as possible the power of making the most of the fund of energy which is available in the individual organism after the maintenance and repair of that organism have been provided for.

We have likened the body to an army. Broadly speaking, an army is organized, equipped, fed, drilled, and led, in order that its executive machinery—which in the last analysis consists of the skeletal muscles of its soldiers—may be enabled to transform the

largest amount of accumulated energy into the mechanical work of marching and fighting. So, in general terms, it may be said that most of the other mechanisms of the human body largely subserve the interests of the organs devoted to the performance of voluntary, purposive mechanical work, viz., the muscles.

It is the skeletal muscles and the skeleton, then, which constitute the executive, work-performing machinery of the body. But it is important to remember that no skeletal muscle is a simple organ. It is made up, as we have pointed out, of two conjoined mechanisms: a contractile, executive mechanism, the muscle proper, and a stimulative, regulative mechanism, consisting of nerve-fibres and gray-matter nerve-cells; that is to say, "a muscle" is essentially a muscle and a nerve besides; or, to put it in another way, muscles are the slaves of the nerve-centres. So close and necessary are the bonds existing between the muscular and nervous systems that, so far as our movements are concerned, the separate, disjoined action of either system under ordinary circumstances is unthinkable. Muscles without their exciting nerves become inert, and motor nerves deprived of muscles to do their bidding are impotent.

What may be termed the gross income of the bodily community is derived chiefly from the productive activity of its purveyor and scavenger members, though the master tissues, whose leading function is the regulation of expenditures, by reason of the active copartnership existing between them and their servants, materially assist toward the accumulation of the gross-income fund. It is pre-eminently the function of the master tissues to turn the net income of the body to the fullest and best account, which net income is what remains from the gross income, after the fixed charges for construction, maintenance, and repair have been met. To secure the wise expenditure of net income, it is needful, therefore, to prevent the master tissues from developing aimless, blundering, or spendthrift habits of action. Prevention, in this instance, can only be secured through the intelligent and adequate training of the neuro-muscular system by means of natural and appropriate forms of exercise.

The muscular system has, then, two sets of servants—its purveyors and its scavengers. The former prepare and serve its food-materials, and the latter clear away the refuse matters which result from the chemical and mechanical processes by which its functional activity is signalized. The digestive and assimilative organs, and the arterial section of the organs of circulation and respiration, belong to the first class, and the venous section of the circulatory and respiratory organs, the perspiratory and urinary organs, constitute the second set. The purveyor and scavenger tissues serve each other, as well as the master tissues, it may be remarked, and are, like the muscles, controlled by

the Archæus of the body, if we may so denominate the nervous system. Despite the number and efficiency of these purveyors, the muscles are obliged to work for their living, since the food supplied to them requires to be appropriated and elaborated. Living muscular substance is continually building itself up out of the proteid, fatty, and carbohydrate material, saline matters, and oxygen brought to it by the blood; that is to say, the lymph. At the same time, muscular substance is continually, by reason of its innate metabolism, forming products to be disposed of by the scavenger tissues, which naturally have most to do during muscular exercise and just after it. A resting muscle forms nitrogenous waste, such as kreatin, and gives off carbonic acid, and probably other matters, too; while in a contracting muscle there is a marked increase of waste given off, which consists chiefly of carbonic acid and sarcolactic acid, there being no marked increase of nitrogenous waste. In either case, the waste products drain away through the lymph- and venous channels, and are eliminated by the lungs, the kidneys, or the skin.

Next to the movements due to muscular action, the most direct and obvious effects of exercise are increased circulation and increased ventilation of the blood. The effect of exercise upon the processes of digestion, sanguification, and excretion is an indirect one; those processes being modified, so far as muscular activity is concerned, by the changes wrought by it in the volume, distribution, or character of the general blood-stream.

The blood-stream flowing through a contracting muscle is at once increased in volume, and very soon changed in its chemical character, especially on its venous side. Some writers on exercise attribute the quickening and increase in the flow of blood through and from a working muscle to the mechanical pressure exerted by its contracting fibres upon the walls of the bloodvessels contained within the muscle. While it would be hardly fair to ignore this view of the matter, it should be said that the weight of evidence is in favor of the opinion that the pressure exerted by the contracting fibres is but a secondary factor in producing the enlarged blood-stream found in a working muscle. Its increase in volume is primarily due to the dilatation of the muscle-arteries and veins, and to the attendant quickening of the lymph-streams within it. This dilatation is a vaso-motor effect, resulting, as it is usually held, from the passage of dilator-nerve impulses, arising in the spinal cord, to the muscular coat of the muscle-arteries. Local diminution of blood-pressure is normally the result of arterial dilatation within a limited muscular area, provided the heart-beat and general blood-pressure remain unchanged. If arterial dilatation occurs within a considerable or enlarged muscular tract, a fall

in the general blood-pressure may result, and the heart be called upon to quicken and strengthen its beat.

On the other hand, the qualitative changes in the blood which issues from muscles in contraction are such, when those muscles are at all numerous, as tend to make the general blood-stream in the right heart and the pulmonary circulation more venous than usual. The carbonic acid, or other waste, stimulates the respiratory centre in the medulla, and leads to an increase in the number and amplitude of the movements of respiration. The flow of blood to and through the heart and lungs causes a quickening and strengthening of the heart-beats. The same changed condition of the blood suffices to dilate the vessels of the skin and start the perspiratory mechanism into action, and thereby to dissipate the excess of heat produced in the blood by the metabolism of the contracting muscles, which are the principal sources of bodily heat. The dilatation of the cutaneous vessels likewise tends to diminish the peripheral resistance to the contraction of the left ventricle of the heart, thus reinforcing the simultaneous fall in the general blood-pressure caused by the dilatation, alluded to above, of the muscle-arteries. Exercise may therefore, through its indirect influence upon the skin, as well as by its direct vaso-dilator effect within the muscles, impose additional labor upon the heart. It is probable that a means of maintaining, or even increasing, the mean blood-pressure of the body, without appealing to the heart for extra effort, exists in the augmented constriction which takes place in the arteries within the abdominal splanchnic area during vigorous muscular labor. By this means the heart is spared redoubled labor, and the digestive organs are left at rest when they ought to rest. The fact that to fill the blood-vessels of the muscles and skin the splanchnic vessels are proportionately emptied, and *vice versâ*, is one of great practical importance, and points to the impolicy of engaging in any but the most moderate muscular exercise while the digestive process is in full course.

The effects of muscular exercise may be summarized under the heads of extrinsic and intrinsic, and these, in turn, may be characterized as direct or indirect.

The most important direct intrinsic effects are: a greater flow of blood and absorption of oxygen and food-materials, and increased metabolism, resulting in mechanical work, the evolution of heat, and the formation of waste within the muscles. Under indirect intrinsic effects belong improved nutrition, structural enlargement, and improved function of the muscles.

The following are to be considered direct extrinsic effects of exercise: vascular dilatation, enlarged flow, and diminution of blood-pressure on the arterial side of the circulation; on the the venous side, an enlarged flow of the lymph- and blood-stream, which has a height-

ened temperature, and an increased amount of waste matters; an increase in the force and frequency of the heart-beats; and an increase in the number and amplitude of the respiratory movements. Perhaps the increased elimination of carbonic acid and watery vapor by the lungs, and their increased taking in of oxygen, had best be placed here. If so, the delivery of completely arterialized blood by the lungs to the left heart may be termed one of the direct effects of exercise.

The following may be classed as indirect extrinsic effects: viz. the depuration of the blood, so far as the action of the sweat-glands, the kidneys, and the liver are concerned in it; the dilatation of the cutaneous vessels, and the consequent cooling of the blood and the maintenance of the normal bodily temperature; vaso-motor changes and the variations in blood-pressure, especially in the abdominal sections of the circulation; and the promotion of the nutrition and functional ability of all the tissues, owing to the better character of the blood furnished them and to the more effective play of the organs of circulation.

All mention of the intrinsic and extrinsic effects of exercise upon the nervous system has been omitted in the foregoing summary, for the reason that those most important effects will be treated separately later on. The capital importance of the extrinsic effects of exercise upon the circulatory and respiratory mechanisms has been most forcibly put by Michael Foster. "The capacity for arduous muscular labor," he says, "is determined, not by the respiratory mechanism alone, nor by the vascular system alone, but by both, and especially by both working together in harmony and concert. The increased ventilation would be idle unless it were accompanied by a quicker circulation, and the quicker circulation would similarly be of comparatively little use unless accompanied by increased ventilation. . . . . And, as a rule, it may perhaps be said that when two men differ in their capacity for strenuous work, such as running a race, the difference, though it is often familiarly spoken of as one of 'wind,' or power of breathing, is in reality not a difference in ventilating capacity, but a difference in the power of the heart to keep up and work in harmony with the increased respiratory movements."

If we bear in mind that next, perhaps, to an adequate supply of proper food nothing so promotes the normal growth and development of the body as well-regulated muscular activity, it is interesting to compare the children of different classes of the population as regards their height and weight.

The very complete and valuable tables published by Dr. Charles Roberts of London touching the mean height and weight and annual rate of increase in the case of some 7800 boys and men, between ten and thirty years of age, belonging to the artisan class on the one hand, and

7700 males, between ten and thirty, belonging to the most favored class on the other, show that the mean height of the artisan class is, for the whole period, about three inches less than the mean height of those belonging to the most favored class. In the latter class public-school boys, military and naval cadets, university and medical students were included. Although the inferior stature of artisans may be to some extent an inherited characteristic, it is held to be chiefly due to "the continuous operation of various conditions of life which retard and arrest growth, and which are most influential when growth is most rapid." Among the conditions so operating "scanty feeding and wearing toil," as contrasted with "abundant nourishment and moderate exercise," occupy a prominent place. These tables also show a progressive gain as regards weight on the part of the favored over the industrial class, both absolutely and in relation to height throughout the entire period under review. At the age of ten years the boys of the most favored class exceed the artisans' sons by one pound in weight; at twelve their excess in weight has increased to four pounds, and at thirteen they are ten pounds ahead. At the age of twenty well-to-do English youths have a mean weight of eighteen pounds more than that of handicraftsmen of the same age living in large towns. As regards chest-girth—and well-directed exercise tells directly upon chest-capacity—the most favored class is clearly superior to the industrial, which superiority is progressively increased until nearly adult life. In another of Dr. Roberts's tables it is shown that the sons of professional men living in the country exceed town boys of the same class by about an inch as regards height at all ages between ten and twenty, and as regards weight by an amount varying from one to seven pounds. It also appears that the sons of soldiers, policemen, messengers, and the like, are from one to four inches less in stature and from four to thirteen pounds less in weight than boys of the same age whose fathers are devoted to intellectual pursuits; that the sons of artisans and factory operatives are the shortest and lightest of all youthful Britons with the exception of idiots and imbeciles of the same age, who have a mean height of an inch less than even youths of the artisan class. American boys seem to be a little taller and a little heavier than their English cousins of the same age and class.

Dr. Boulton, another English student of anthropometry, made observations extending over ten years on a certain group of children, all of whom were healthy and the offspring of well-to-do parents. Dr. Boulton finds that "average English children brought up under favorable circumstances grow from two to three inches a year. A growth of less than two inches or more than three should excite apprehension; the former would indicate arrested development. The rate of growth should be regular, and being so prognosticates future good stature."

As to weight for height, whether a child grows two, two and a half, or three inches in a year, weight for height should be in each case identically the same, and all healthy children should grow broad in proportion to their height. "Between three and four feet the increase in height should," he says, "be two pounds per inch, and between four and five feet two and a half pounds per inch. Well-nourished children, of healthy parents in favorable surroundings, generally attain these averages. But what of children that fall below the standard? I find there is a seven-pound margin of safety, and that children falling more than seven pounds below this standard are devoid of reserve of stamina on which to draw, and consequently succumb quickly to many constitutional diseases. This, then, may be called the preventive medicine margin beyond which lies the dangerous land of cachexia."

There is a condition of mind and body not infrequently seen nowadays in children and youths, especially among females, which is characterized by an irritable, easily overwrought, and unsteady nervous system, arrested muscular development, disordered digestion, and enfeebled powers of assimilation; which might well be called *cachexia scholastica*, since it is largely, and sometimes directly, brought about by ignorant and foolish parents and teachers, who force and cram and overwork the undeveloped brains of children, and at the same time, by neglecting or frowning upon their play and exercise, do their best to retard the growth and development which they ought to promote and might regulate.

The late Alexander Maclaren's experience, with the first squad of twelve non-commissioned officers sent to him to be qualified as instructors in gymnastics in the British army may serve to show how systematized and well-directed exercise may be made to influence bodily development in a comparatively short time. The twelve men alluded to ranged between nineteen and twenty-nine years of age, and had seen from two to twelve years' service. At the end of eight months' gymnastic training the increase in the measurements of the men was as follows:

	Weight.	Chest girth.	Forearm girth.	Upper-arm girth.
The smallest gain . . .	5 lbs.	1 inch.	$\frac{1}{4}$ inch.	1 inch.
The largest gain	16 "	5 inches.	$1\frac{1}{8}$ inches.	$1\frac{3}{4}$ inches.
The average gain. . . .	10 "	$2\frac{7}{8}$ "	$\frac{3}{4}$ inch.	$1\frac{3}{4}$ "

"The muscular additions," says Maclaren, "to the arms and shoulders and the expansion of the chest were so great as to have absolutely a ludicrous and embarrassing result, for before the fourth month several of the men could not get into their uniforms, jackets,

and tunics without assistance, and when they had got them on they could not get them to meet down the middle by a hand's breadth. In a month more they could not get into them at all, and new clothing had to be procured, pending the arrival of which the men had to go to and from the gymnasium in their great-coats."

Enough has been said, I think, to show that muscular exercise exerts a potent and important influence upon the growth of the body and upon the elaboration and perfecting of its more familiar systems of organs; but thus far its most important effect, that upon the nerves and brain, has only been alluded to. The neural element involved in muscular exercise is oftener overlooked than recognized by the mass of writers on the subject. Maclaren, whose book on *Training in Theory and Practice* is one of the best of its class in the English language, defines exercise as "muscular movement" simply, and declares its object to be "the destruction and renovation of tissues." This is the ordinary view, from which one finds but little deviation in the vast majority of the textbooks on physiology, and of the books and articles on exercise, whether they have been written for school-girls or medical students.

"We seek in vain in most physiological textbooks," says Du Bois-Reymond, "for instruction respecting exercise: if it is given, only the so-called bodily exercises are generally considered, and they are represented as merely exercises of the muscular system. Therefore it is not strange that laymen in medicine, teachers of gymnastics, and school-teachers believe this. Yet it is easy to show the error of this view, and demonstrate that such bodily exercises as gymnastics, fencing, swimming, riding, dancing, and skating are much more exercises of the central nervous system, of the brain and spinal marrow. It is true that their movements involve a certain degree of muscular power; but we can conceive of a man with muscles like those of the Farnesian Hercules who would yet be incompetent to stand or walk, to say nothing of his executing more complicated movements."

The arm of the blacksmith has been brought into play so often, by writers and talkers on exercise, that every school-boy credits the statement that muscles grow larger, harder, and stronger when duly exercised, and become weak, flabby, and wasted if they are suffered or forced to remain inactive. It is less obvious, though it can hardly be doubted, that use and disuse work similar effects in the case of nerve-cells and fibres, both sensory and motor. Though conclusive evidence is lacking on this point, it seems probable that exercise of the muscles not only reacts upon the nerves and centres, with which they are connected, in such wise as to enhance the power and ease with which they originate and transmit motor impulses, but that it also leads to an increase in the number, size, and elaboration of their parts. That disuse of end-organs, both sensory and motor, leads to atrophy of their

nervous connection has been clearly made out. Meynert quotes Mendel as saying "that nerve-tissue, like muscular tissue, increases during mental work."

The fact should never be lost sight of that a single muscle is not a simple organ, but is made up of two clearly-distinguishable though conjoined mechanisms—a contractile, executive mechanism, the muscle proper, and a stimulating, regulative mechanism, consisting of nerve-fibres and gray-matter nerve-cells. Each mechanism has its blood-vessels and lymph-capillaries for supplying food and drainage, and the amount of blood supplied to each is proportionate to its functional activity. If in life the two mechanisms become dissociated, or if either suffers from malnutrition, unregulated exercise, or structural depravity, the dual organ is thrown out of gear, and its working becomes disordered or abolished, in much the same way as when the attempt is made to split a human being into a mental part and a bodily part, and to train the dissevered fractions to functionate as entities. Muscular movement is, then, a resultant effect due to the balanced working of the conjoined mechanisms alluded to. The nervous mechanism is concerned in a somewhat higher kind of work than that of its muscular colleague, and may be said to *represent* the movements of which the latter is the seat and instrument. Between the nervous arrangement which represents the twitch of a single subcutaneous muscle inserted into the base of a hair-follicle, and that which represents and governs the varied and rapid muscular adjustments which characterize the hand and fingers of a cunning craftsman or artist, there exists every grade of complication.

If we compare an adult man and one of the highest of the lower animals in respect to the movements of which they are capable, we find that they possess many in common, but that man is distinguished from the brute by certain movements, such as those involved in maintaining the erect posture and in the action of the hands and vocal organs, and that, corresponding to these two classes of movements, there are two classes of nervous mechanisms by means of which they are represented. These mechanisms have been well termed fundamental and accessory, respectively.

Similarly, it is demonstrable that while the human infant and adult possess many nervous mechanisms identically alike in structure and function, the adult is characterized by certain other mechanisms whose structural peculiarities, connections, and powers have been evolved and superadded as the result of growth and training. The law of evolution, as applied to the nervous system, is coming to be very generally recognized by neurologists. It is a law which educators, both mental and physical, should ponder upon and be guided by. Dr. Ross of Manchester, England, in his *Diseases of the Nervous System,* in

speaking of this law, which was originally enunciated by Herbert Spencer, describes it as "a progressive integration both of structure and function, during which there is a passage from the uniform to the multiform, the simple to the complex, from the general to the special." "During the evolution of the nervous system of man," he says, "the fundamental portion is first developed. The nervous system of man is at first similar to that possessed by all animals which possess a nervous system, or, at any rate, all those which are sufficiently elevated to possess a spinal cord; but as development proceeds the nervous system of man becomes gradually differentiated from that of an ever-increasing number of the lower animals, while still maintaining a general likeness to the nervous system of the higher animals up to the time of birth. This, then, constitutes the fundamental portion of the nervous system of man; but after birth the accessory portion, which up till this time only appears in a rudimentary condition, now undergoes progressive development. It will thus be seen that the fundamental portion is first developed, and that the superaddition of the accessory portion greatly increases the multiformity, the complexity, and the specialty of the human nervous system, and that it is the latest product of its evolution."

As might be expected, the structural elements of the nervous system follow this law. The many-branched nerve-cells, having a process prolonged to form the axis-cylinder of a nerve-fibre, are the most highly organized and special of nerve-cells, but they begin as small, round, uniform, unbranched cells. The medullated nerve-fibre, made up of axis-cylinder, sheath of white substance, and outer investing membrane, is the highest form of nerve-fibre. At the other end of the series stand the primitive nerve-fibrils, a bundle of which may be said to constitute an axis-cylinder. Among intermediate forms are axis-cylinders with no sheath whatever, axis-cylinders covered only by a sheath of white substance, and non-medullated fibres, consisting only of an axis-cylinder enclosed in a fine, thin, structureless sheath. At birth the fundamental portion of the nervous system of a human infant is characterized by the presence of branched cells and medullated fibres in contradistinction from the rudimentary accessory portion, which contains small round cells, primitive fibrils, and non-medullated fibres. Later, if all goes well, the round cells become branched and the non-medullated fibres become medullated.

Ross has much to say of the distinction, noted above, between accessory and fundamental structures and functions. "The movements of the hand," he says, "afford the best example of the accessory functions of the spinal cord. These movements are peculiar to man, and by far the greater number of them are acquired after birth. It may therefore be expected that the development of the structure which

represents these movements in the spinal cord will also take place after birth. The movements which are most characteristic of the upper extremity in man are those of pronation and supination of the forearm and the complicated movements of the hand and fingers; and it is exceedingly probable that the structural representatives of some, if not all, of these movements are to be found in the median group of cells. These cells appear at a late period of the development of the cord, hence they form a specialty of structure which corresponds to some specialty of function. Again, they maintain a small size even in the adult cord, and consequently may be expected to preside over the action of small muscles, both of these conditions being realized in the hand.

"The smaller median area in the lumbar enlargement of the cord," says Ross, "presides probably over the movements of the lower limbs which distinguish the adult man from the lower animals, and also from the human infant. These movements are mainly executed by the extensors of the leg on the thigh, and probably also by the adductors and by the flexors of the foot on the leg. Indeed, the slight elevation of the ball of the toe, so as to allow the passive leg to swing forward by its own weight in walking, is the last movement acquired by the child; and we shall subsequently see that it is the first movement to be affected by disease. If, then, the median area of small cells be the structural correlative of the later-acquired and more special movements of the limbs, it must be absent in those portions of the cord which do not supply nerves to limbs; and we have already seen that this area is absent in the dorsal and upper cervical regions of the cord."

The same author attributes the spinal-cord regulation of fundamental voluntary movements to its antero-lateral group of cells, and notes that "the cells of this group always maintain the lead in the course of development. It is not only that they begin to develop and assume processes at an earlier period than the cells of the other groups, but the greater portion, if not all, of them appear almost simultaneously, and maintain an equal rate of growth during development. It may be expected, therefore, that this group will regulate the fundamental actions or those which are carried on in a reflex manner, and which are in great measure independent of the cephalic ganglia. In this connection the intercostal muscles, the diaphragm, abdominal muscles, and the muscles constituting the floor of the pelvis will immediately suggest themselves."

There are certain areas in the gray matter of the fore-brain of man whence proceed, it is now generally held, stimuli to the most important groups of voluntary muscles. In one of these regions are the centres which control the different groups of muscles of the upper extremity; and for the sake of simplicity we may consider that the centres of the muscles which move the shoulder, elbow, wrist, and fingers lie near to and are connected with one another. The actions of the shoulder and

elbow are fundamental and well organized in the infant, as compared with those of the wrist and fingers, which are accessory and later acquired. In order that the action of the different segments of the fore-limb should be properly co-ordinated as to time, force, direction, and degree, their motor centres must habitually discharge their stimuli in due sequence and degree. Experiments on young puppies show that their motor areas are not sufficiently developed until they are ten days old for them to make voluntary movements with their limbs. Ferrier declares that "the degree of development and control which a puppy reaches in ten days or a fortnight is not attained by the human infant under a year or more." The infant, through the growth and development of the appropriate accessory centres, first gains co-ordinative control over its foot and leg, then over its arm and hand, and later over tongue and lips. It is evident that the arms of a blacksmith and those of a five-year-old boy and of an infant differ greatly as regards size, strength, and skill; but the differences which exist between them reside in the nervous mechanisms which represent the movements of which their respective muscles are capable, rather than in the muscles themselves. Not only are the motor nerves of the blacksmith the largest, but the cells in the motor areas of his brain and spinal cord are also larger, more branched, and more widely connected with other cells. Exercise plays, if not the predominant, at least a very considerable, part in producing this result. The effects of exercise are at once seen if one compares the right and left arms of the average blacksmith with one another. It is well known that the centres which control the right hand are situated in the cortex or outer layer of gray matter of certain portions of the left fore-brain, and that those which control the left hand are in the right fore-brain. Flechsig, who has made exhaustive studies as to the course and number of the motor-fibres which connect the muscles of the two extremities with their respective main centres, is quoted as saying that the number of fibres going to the right hand is to the number of fibres going to the left hand as three to two.

The fact that cerebral action is a large factor in voluntary muscular movements has been strikingly stated by Foster. "It is clear," he says, "that, admitting the pyramidal tract to be the ordinary channel by which volitional impulses pass to, or by which the will gains access to, the motor mechanisms immediately associated with the anterior roots of this or that spinal nerve, we must also admit that those volitional impulses passing along the pyramidal tract, or at least some of the processes constituting the will, are in connection with, and thus influenced by, the condition of other parts of the brain. When, for instance, a gymnast executes a skilled voluntary movement, in which all his four limbs and other parts, as well, perhaps, of his body, are involved, it

is probably the case that changes of the nature of efferent impulses sweep down his pyramidal tract, and that these impulses, starting in a definite order from his cortex—that is to say, having undergone a certain amount of initial co-ordination at their very origin—meet with further co-ordination in the spinal gray matter, which serves as a set of nuclei of origin for the motor nerves concerned in the movement, before they issue as ordinary motor impulses along the anterior roots. But this is not all. Should the gymnast's semicircular canals happen to be injured, and his cerebrum thereby be troubled, or mischief fall on some other part of the brain which like this has no direct connection with either the pyramidal tract or the motor cortex, the movement fails through lack of co-ordination, though both the cortex, the pyramidal tract, and the spinal-motor mechanism remain as they were before. Obviously, the carrying out of a voluntary movement is a very complex proceeding, and the motor cortex with the pyramidal tract is only one part of the whole mechanism: so far from the whole business being confined to these, it is perhaps no exaggeration to say that in each movement of the kind most parts of the whole brain have a greater or less share."

The mere disuse of a muscle causes it to diminish in size. The most extreme forms of muscular atrophy and paralysis are due to diseased conditions which originate in nerve-centres or nerve-fibres. Lesions in the central nervous system may cause the bones to atrophy, as well as the muscles. The development of a group of muscles of an entire limb, or of one side of the body, may be arrested by reason of certain forms of central nervous disease which occur in infancy and childhood. Observations made upon the brains of persons born with an arm or hand lacking, taken in connection with observations made on the brains of those who have had a hand or arm amputated, go to prove that the suppression or considerable diminution of certain movements brings about a condition of atrophy or arrested development, as the case may be, in those centres which would normally represent such movements. One may attain to the stature and semblance of manhood, and yet, through the arrested development of certain of his motor centres, be nothing better than an infant or a mere animal as regards his powers of action; while paralysis and atrophy may reduce a man, stage by stage, to the condition of an untrained child or of a helpless idiot, or even to that of a living corpse.

The progressive functional improvement—*i. e.*, the development of the nervous mechanisms which represent our bodily movements—is the most important effect of exercise of the muscles. It is not altogether clear just how it comes about that through trial and repetition an action, which is at first a difficult feat, becomes a pleasurable accomplishment, then a routine performance, and at last an almost

instinctive act. But there is a settled conviction, among those who know most about both healthy and diseased nerves, that the frequent or habitual passage of stimuli from a given group of cells through definite fibres to the muscles concerned in a given movement leads to some kind of rearrangement of the molecules composing the irritable protoplasm of fibres and cells "whereby new paths are made, or the material of old paths rendered more mobile," so that less and less resistance is offered to the passage of subsequent impulses from the same source. Somehow or other, the memory of past actions and the stimuli which evoked them becomes imbedded or organized in the centres of the motor areas. The mental accompaniments of exercise and the probable effects of exercise upon the development of the nervous system have been treated in a highly suggestive way by Charles Mercier, an English alienist, from whose book, *Sanity and Insanity*, the following extract is taken:

"By the mere force of repetition and of the definite organization which repetition brings about novel acts become habitual, habitual acts become automatic, and automatic acts become reflex. The difference between the several degrees of consolidation are thus marked. An act is habitual when it occurs with perfect facility, but yet requires the guidance and direction of higher centres for its performance. An act is automatic when it has become so far organized that the mechanism which actuates it is complete in itself and, given the necessary impression, the action occurs without any guidance or regulation from higher centres. Such are the acts of walking, the fingering of musical instruments, the manipulation in many handicrafts, the movements of the lips and tongue in speaking. All of these movements occur with a celerity and an accuracy which indicate thorough organization; all of them can be performed without direct guidance from the higher centres or while the higher centres are otherwise employed—while, as we say, we are "thinking of something else." Lastly, when organization is complete movements become reflex; that is to say, not only do they occur on the occurrence of their appropriate stimulus, but they occur necessarily. A nerve-channel is so completely formed in itself and the neighboring currents are so built out that when once the process is started it goes on to completion as a matter of necessity, and no action of the higher centres can interfere to prevent or alter it. Such movements are those of blinking, of swallowing, of coughing, and the like.

"Since states of mind are but the obverse side, or, as I have termed them, the shadows of nervous processes, it was to be expected that repetition, which has so great an effect on nervous processes, should have an effect equally great on the mental states; and this we find to be the fact. The law is that a new nervous process is attended

by the most vivid mental state; and that the more unlike the nervous process is to previous processes the more vivid is the mental state that accompanies it. . . . . When an act has become habitual it has so little mental accompaniment that, as we put our watch down on the dressing-table, we are uncertain whether the instant before we wound it up or not. When the act becomes automatic, and, still more, when it becomes reflex, there is no appreciable mental accompaniment to the discharge of the centre that actuates the movement. . . . .

"Hence it appears, since the most fixedly and completely organized centres are the lowest and most recent, and the least organized are the highest, that the mental accompaniment of the nervous discharge gradually increases in its vividness from the lowest centres to the highest. Quite at the bottom are the mechanisms actuating directly the movements of the heart and other viscera which are in health absolutely void of mental accompaniment; above these are the mechanisms for breathing, swallowing, and other reflex actions, and with their activity a faint glimmering of consciousness is occasionally perceptible. Above these again are layer upon layer of mechanisms actuating automatic and habitual acts of every degree of fixity, and with their action appears a certain amount of consciousness, broadening from a mere glimmer at the bottom through an ever-lightening daylight to full dawn at the top. The action of the highest centres is accompanied by the broad daylight of wakeful consciousness and the occasional concentration of energy in particular tracts, and the vigorous and energetic discharges of these tracts from time to time are accompanied by mental states of exceptional vividness, which, in comparison with the usually quiescent condition of consciousness, may be likened to bursts of sunshine on a cloudy day."

From careful studies made as to the character of the dreams of the blind it appears that the memory of visual objects is not organized until between the fifth and seventh year of life. Persons born blind do not dream of objects in the outer world, and those who become blind before attaining their fifth year do not dream of objects seen by them before their loss of sight. They are blind-minded as well as blind-eyed as regards such objects. There are authentic cases recorded of persons whose memory of objects, seen before the access of their blindness, persisted for twenty, thirty, and even fifty years. Then the record of their visual impressions became effaced, and they ceased to dream of objects in the outer world. The case of a man born without either hands or feet is in point here. Although he had eyesight, he did not dream of executing hand or foot movements, yet he had sufficient use of his stumps to write what is termed a good hand. There was no record of hand or foot movements in the centres which ordinarily control such movements,

so that he was unable to dream of movements which he had never executed. On the other hand, the instances are very numerous in which men who have lost a limb by amputation could feel their fingers or toes while awake, and dream in sleep, or when awake, of making complicated movements with their lost members. "Persons who have had an arm amputated," says Dr. S. Weir Mitchell, "are frequently able to will a movement of the hand, and apparently to execute it to a greater or less extent. A small number have entire and painless freedom as regards all parts of the hand." They must be blind-minded, indeed, who can deny in the face of such facts that muscular movements play an important part in the development of brain-power.

Mercier, in *The Nervous System and the Mind*, devotes much space to an ingenious and suggestive discussion of the nature of bodily movements, and their relations to the structure and functions of the nervous system; his point of view being that "the only way to get at a knowledge of the intimate arrangement of nerve-centres is by a systematic study of the movements which they actuate, and which derive their character from the mode in which the centres are arranged." Mercier bases his attempt "to organize into knowledge the facts concerning the nervous system" upon the well-known doctrines of Herbert Spencer and Hughlings Jackson, with which doctrines Ross is in general accord. But Mercier makes little use of the embryological point of view, in accordance with which Ross classifies movements as fundamental or accessory. Mercier's central and peripheral movements are approximately identical respectively with the fundamental and accessory movements of Ross, central movements being those of the trunk, shoulder, or hips, and peripheral movements being those of the digits, mouth, and eyes. Among typical central movements are included those concerned in walking, riding, swimming, rowing, bicycling, and the various feats of gymnastics; while typical peripheral movements are those involved in writing, watchmaking, piano- and violin-playing, and sewing. Intermediate movements are characterized as "more central" or "more peripheral." A "more peripheral movement" is not necessarily, though it may be, a movement of a point farther from the trunk. It always means a movement less closely associated with the great trunk system, and one involving the action of more individualized muscles. A movement means "any set of co-ordinated muscular actions." Central movements are "*tonic* in character, those of the other (class) approximately *clonic*." Central movements are represented in the cerebrum—peripheral movements in the cerebellum.

Mercier concludes that "central movements are continuous in duration, vague in limitation, few in number, the same in character, and form a general, approximate, or coarse adjustment; that progress toward the

periphery brings us to movements that are more intermittent in duration, more precisely defined, more numerous, more diversified, and more specially adjusted to particular ends; and that at the eyes, the articulatory apparatus, and the digits, where we reach the extreme periphery, all these characters reach their highest degree of development."

Having called attention to the facts that the character and efficiency of movements differ according as they are associated with other movements with which they are coincident in time, or with which they are related as parts in a series, Mercier forms two other great classes of movements—viz. "those that are combined with other movements with which they are simultaneous, and those that are combined with other movements in sequence." "It is extremely significant," he adds, "that this division coincides with the other division already considered, those movements which are combined (co-ordinated) in simultaneity being mainly *central*, while those which are co-ordinated in succession are predominantly *peripheral*. . . . . Co-ordination in simultaneity affects the central movements first, and next spreads toward the periphery, and affects the most peripheral movements last and least. Co-ordination in succession involves the most peripheral parts most often and in the most prolonged and complex sequences; and when, as often happens, the succession begins centrally and spreads to the periphery, it is the most peripheral movements to which all the others are subservient and act as aids and adjustments.

"Co-ordination of movements in succession is effected in the cerebrum, and co-ordination of movements in simultaneity in the cerebellum. . . . . Spasm due to lesion of the cerebellum is in all respects the antithesis of Jacksonian epilepsy. In Jacksonian epilepsy the spasm begins at the extreme periphery, at the lips, fingers, or toes. Cerebellar spasm begins in the most central muscles. It produces, first, opisthotonos and retraction of the head. Jacksonian epilepsy spreads centripetally up the limbs of the trunk. Cerebellar spasm spreads centrifugally from the trunk down the limbs. In Jacksonian epilepsy the spasm is always clonic. It is always jerky, intermittent, coming on in sudden paroxysms, interrupted by periods of complete absence. Cerebellar spasm is continuous (tonic).

"Thus we find that the functions of the cerebrum and cerebellum are antithetical and complementary to one another. The cerebellum represents, first and most, the most central muscles, and the intensity of representation decreases toward the periphery. The cerebrum represents, first and most, the most peripheral muscles, and the intensity of representation diminishes toward the centre. The cerebellum maintains a continuous same action; the cerebrum breaks up the continuous same action into interrupted and various movements. The cerebellum actuates co-ordinations in simultaneity; the cerebrum actuates co-ordi-

nations in succession. The cerebellum regulates co-ordinations in space; the cerebrum regulates co-ordinations in time."

Stuttering is a functional disturbance of the central nervous system which finds expression through disorderly spasms in certain muscles concerned in vocal utterance. Stuttering affords striking evidence of the mischief which may arise at the very threshold of education through ignorance of the doctrine of muscular exercise which I have endeavored to set forth in this article.

Audible speech is a tissue of sound-waves in which musical sounds serve for woof and unmusical sounds for warp. The raw material out of which our speech is wrought is found in the bellows-blast of air which is expelled from the lungs, during the expiratory phase of respiration, through the slit of the glottis, whose membranous edges are thrown into vibration. The vibrations of the vocal cords derive their character from the action of the laryngeal muscles, and being communicated to the tide of laryngeal air give rise to the sound we call voice. As the stream of vocalized air continues its upward and outward course through the tubular passage which leads from the larynx to the lips, it becomes subjected to a series of interruptions and resonations brought about by the muscles of articulation. Thus certain laryngeal sounds are intensified, and certain noises termed vowels and consonants are added to or superposed on them, and articulate speech is the result. The production of articulate speech, therefore, comprises three highly complicated series of movements—which are effectuated by muscles situated in the chest, throat, and mouth respectively, co-ordinated into a single act. The three sets of muscles may be designated, according to Mercier's terminology, as central, intermediate, and peripheral respectively; and we may add that the neuro-muscular mechanisms of breathing are of the fundamental kind, while those concerned in phonation and articulation are relatively accessory, particularly the latter. It is hardly necessary to show, though it may be stated by way of reminder, that of these three orders of movement articulatory movements are not only more numerous, varied, and arhythmical than those of voice and breathing, but are also more precisely limited, more highly specialized, more artificial, more easily disturbed and marred, and require more careful, prolonged, and intelligent training to secure their full development. It is also interesting to note that the nerve-centres which represent the three different orders of movement pertaining to speech-production are found in different levels of the cerebro-spinal system, and become organized and fully capable at different periods during the development of the brain.

Kussmaul, in his *Die Störungen Der Sprache*, characterizes stuttering as a "spastic neurosis of co-ordination which hinders the

utterance of syllables by convulsive contractions—at the stop points for vowels or consonants in the articulation-tube." He goes on to say: "If we examine more closely the condition that, in stuttering, prevents the proper joining of syllables, we find that the three forms of muscular action concerned, viz., the expiratory, vocalic, and consonantal, are not co-ordinated. The regulating mechanism of the nerve-centres which brings about the harmonious interplay of these muscles in attuning the sounds which make up the syllables, or, as Merkel puts it, in vocalizing the sounds, are thrown into disorder by insignificant peripheral excitations, and still more frequently by excitations of central origin. The three muscular actions mentioned above, which co-operate in the articulation of every syllable, are not co-ordinated either as to the force or order of their contractions. On the one hand, the action of the breathing muscles concerned in speech is at fault, and, on the other, the action of the vocalic and consonantal muscles is convulsive. The contractions of these muscles, instead of proceeding quietly at normal intervals, take on the form of tonic or clonic spasms."

Though any or all of the series of organs concerned in producing speech may be affected in one who stutters, the respiratory muscles are almost certain to be at fault. "Stutterers always lack," says Kussmaul, "that control of the breath which is requisite for speech. They inhale too little air for their purposes, are not sufficiently economical of it, and sometimes are obliged to draw breath in the middle of a word."

Experience has shown abundantly that unless the central breathing muscles are first set right, efforts directed toward restoring the co-ordinated action of the throat and mouth-muscles are largely wasted. It is a most significant fact that those who are most successful in the treatment of stuttering have instinctively taken the law of the evolution of the nervous system as their guide. As a rule, they begin their efforts with gymnastic exercises of the breathing muscles and later on direct their attention to developing normal habits of action, first in the muscles of phonation and then in those of articulation. In other words, their training of the accessory neuro-muscular mechanisms is based on the preliminary development of the normal powers of the fundamental and intermediate mechanism of the series.

In 1893 I had occasion to determine the amount and distribution of the stuttering habit in the Boston public schools. In a total of 63,474 pupils, 500 stutterers or stammerers, or 0.78 per cent., were found. The distribution of stutterers by grades was as follows: kindergartens, 0.55; primary schools, 0.84; grammar schools, 0.75; high schools, 0.78. The largest percentage was found in the second year of the primary school course—*i. e.*, after a year's study of read-

ing. I am strongly inclined to the opinion that in a large proportion of stutterers the habit is due to unnatural and inverted methods of teaching reading, which is begun in the primary school before the children have acquired adequate control over their organs of speech. To my mind it is quite as needful for the teacher of reading to apply the principles of physical training to the prevention of stuttering as for the vocal trainer to apply those principles to curing it. The natural development of the vocal organs involves so much exercise which is essentially gymnastic in its nature as to lead me to hold that if the motor education of the younger children in the public schools were rightly organized in the departments of free play and gymnastics, a considerable amount of stuttering might be prevented. But so long as teachers in the kindergarten and the primary schools are not obliged to follow the most natural and rational methods of teaching speech and reading, the schools will continue to deserve the appellation of "nurseries of stuttering" which was long since bestowed upon them by A. Melville Bell, the well-known inventor of visible speech.

"The muscles not only," says Sir James Crichton-Browne, the eminent English alienist, "by the locomotion which they render possible enormously widen the field from which our sense-impressions are gathered, but also, by the experiences which their own activities involve, expand our mental resources a thousand-fold. An analysis of our ideas at once reveals to us that we have few that are of purely sensory origin: our ideas of form are not mere revived optical impressions, which are properly limited to color, but ocular impressions combined with ideal ocular movements. Our idea of a circle is a combination of an ideal colored outline with an ideal circular sweep of the eyeballs, or it may be of the tactile impressions coinciding with an ideal circumduction of the arm or hand, or perhaps both these factors combined. And so it is with our ideas of weight, distance, and resistance, which all involve sensory and motor factors; and to revive in memory any such ideas is to revive both the sensory and motor elements of their composition, and to repeat definitely in certain nerve-centres the processes which correspond with certain motor acts.

"Now, the centres of motor ideation require to be exercised in order that they may be properly developed, and may contribute usefully to mental processes; and hence muscular training is likely to assume a more important and precise place in our educational systems of the future than it has hitherto done.

"These facts, that cerebral centres never properly exercised do not develop, and that when once developed they are not so liable to waste on the withdrawal of their appropriate stimuli or when they are cut off from their natural activities, strongly inculcate the importance of

educating every centre at its nascent period, and the danger of postponing education till the nascent period is over. A large district of the brain is made up of motor centres and is concerned in motor ideas. The growth of that district is evidently to some extent dependent on muscular exercise, and if that is withheld at the growth-period, the development of that district is arrested. It is not only so, but that district is made up of a series of centres in relation with different groups of muscles, and each centre is dependent for its development upon the activity of its own group of muscles; and the defective exercise of any group of muscles during the growth-period of its own particular centre (the growth-periods in most of the motor centres having different starting-points) will result in the dwarfing of that centre, and a corresponding hiatus or a general weakness must exist in the whole mental fabric.

"From this we might deduce that swaddling-bands so applied at birth as to restrain all muscular movements, and kept on during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance. We should also have to infer that in order to build up a sound and vigorous brain we must ensure free exercise to the different groups of muscles in the order of the development of their centres, and must in no degree interfere with the natural sequence of their evolution. That being so, we must necessarily ascertain what that natural sequence is which is so important a guide to education, for in our present ignorance of it we may unwittingly be doing much mischief.

"Suppose that we are encroaching on the time at which hand-centres ought to receive their most valuable education—their nascent period—and are devoting that time to the cultivation of the tongue and lip-centres, then we should be impairing the full development of the brain; for the hand-controlling centre, if not fully exercised at its nascent period, can never afterward attain to the highest cunning. But it seems that not only tongue, but hand, and foot, and eye, and arm, and every muscle of the body, must be trained in due season if education is to do what we expect of it, and result, not in headaches and imbecilities and nervousness and insanity, but in well-balanced growth of body and mind.

"The differences which we notice between man and man in deportment, gait, and expression are but the outward and visible signs of individual variations in the development of the motor-centres of the brain; and the stammerings, grimaces, twitchings, and antics which are so common and annoying alike to those who suffer and those who witness them are probably, in many instances, the effects of neglected

education of some of those centres, and might have been abolished by timely drill and discipline."

It must be evident, I think, that muscular exercise deserves more attention than is usually given it, and that, when properly chosen, regulated, and guided, it not only "does a man good," as we so often hear it said, but makes him better; at least, it may make him a better man, in many respects, than his father was, and enable him to transmit to his progeny a veritable aptitude for better thoughts and actions. Herein lies the power of the race for self-improvement and the evolution of a higher type of man upon the earth.

"The body of the accomplished man becomes," says Bagehot in his *Physics and Politics*, "by training different from what it once was, and different from that of the rude man; it is charged with stored virtue and acquired faculty, which come away from it unceasingly. . . . . The special laws of inheritance are, indeed, yet unknown. All which is clear is that there is a tendency, a probability, greater or less according to circumstances, but always considerable, that the descendants of cultivated parents will have, by born nervous organization, a greater aptitude for cultivation than the descendants of such as are not cultivated, and that this tendency augments, in some enhanced ratio, for many generations.

"I do not think that any who do not acquire this notion of a transmitted nerve-element will ever understand 'the connective tissue' of civilization. We have here the continuous force which binds age to age, which enables each to begin with some improvement on the last, if the last did itself improve, which makes each civilization not a set of detached dots, but a line of color surely enhancing shade by shade. There is, by this doctrine, a physical cause of improvement from generation to generation, and no imagination which has apprehended it can forget it; but unless you appreciate that cause in its subtle materialism, unless you see it, as it were, playing upon the nerves of men, and, age after age, making nicer music from finer chords, you cannot comprehend the principle of inheritance either in its mystery or its power.

"These principles are quite independent of any theory as to the nature of matter or the nature of mind. They are as true upon the theory that mind acts on matter, although separate and altogether different from it, as upon the theory of Bishop Berkeley, that there is no matter, but only mind; or upon the contrary theory, that there is no mind, but only matter; or upon the yet subtler theory, now often held, that both mind and matter are different modifications of some one *tertium quid*, some hidden thing or force. All these theories admit—indeed, they are but various theories to account for the fact—that what we call matter has consequences in what we call mind, and that what we call mind produces results in what we call matter; and the doc-

trines I quote assume only that. Our mind, in some strange way, acts on our nerves, and our nerves store up the consequences. Somehow, the result, as a rule and commonly enough, goes down to our descendants. These primitive facts all theories admit, and all of them labor to explain."

We have seen that the effects of exercise upon a single muscle are chiefly two. On the one hand, there results a general condition which may be termed the heightened health of the neuro-muscular machine, which state of health involves the attainment and maintenance of a normal degree of size, strength, and working power in its structural parts; and on the other hand, a more complex and special effect—viz. the acquisition or organization by its neural parts of proper habits as regards the origination, transmission, and regulation of stimuli. The ends of exercise may then be characterized as the promotion of health and the acquisition of correct habits of action. The first is a hygienic end, while the second is a distinctly educational end. It matters not whether we consider a single muscle, which admits of only a single limited motion, or a group of muscles, or the communal structure we call the human body, or a class of school-children, or a regiment of soldiers: the ends of exercise in each case are the same, and can only be attained by a combination of hygienic and educational measures.

It is well to emphasize the beneficial effects of exercise upon the nutrition of the body and its component parts, since in the last analysis health is very largely a matter of nutrition. Physical education is too frequently conceived to be a branch of hygiene. It is rather a branch of pedagogic discipline, and physical educators should be classed as teachers and not as hygienists. Doubtless there is ample justification for making physical training a co-ordinate department, especially in city schools, because of the efficacy of muscular exercise to promote general bodily health; but equally weighty arguments for the efficient organization and generous support of physical training are deducible from the educative value of systematized muscular exercise. Indeed, it may be questioned whether the hygienic ends of physical education can be obtained in full measure by instructors and trainers who do not recognize and strive to realize its educative ends as well.

The main field of education is, then, the nervous system. The law of the evolution of the nervous system seems to me a sure and serviceable criterion of the worth and propriety of educational procedures of every kind, since it affords a means of comparing our conventional methods of educating the individual with Nature's method of educating the race. Physical training may be defined as: the regulated practice of neuro-muscular exercise, under such conditions as serve to promote the health of the organism and to develop and discipline its motor functions, either in a general or special way.

The principles of all forms of physical training, however various and divergent their special ends may be, are based upon the power of the nervous system to receive impressions and register them or their effects; in other words, upon its ability to memorize the part it has played in acquired movements, and on occasions to recall and revive such movements.

It is coming to be clearly recognized that the function of our public and preparatory schools and colleges is not to fit their scholars to engage as specialists in either intellectual, commercial, or industrial pursuits. The same rule holds good as to the kind, or rather degree, of physical training which should be aimed at in our schools and colleges. It is not their business to train up ball-players, carpenters, clerks, or professionals of any kind. General bodily training is the kind demanded; but training so general that it is vaguely or spasmodically or half-heartedly carried out, or, worse still, that is left to run itself in accordance with the whim or frenzy of the persons to be trained, will surely and deservedly fall short of success. Intelligence, system, organization, funds, and patience are just as imperatively required in physical training as in the training of engineers, musicians, or philologians.

Any system of physical training that does not provide first of all and continuously for the training and exercise of the central or fundamental groups of muscles will fail utterly in securing either the hygienic or the educational end of exercise; and any system which substitutes training of the accessory neuro-muscular mechanisms for that of the fundamental ones, or which exacts undue work of undeveloped accessory centres, or attempts their training out of the proper order of their ripening, is bound to contribute more toward the promotion of brain-forcing than toward its prevention.

The most fundamental mechanisms of the trunk are those which are concerned in the movements of respiration and of circulation. They are quite fully organized at birth, but the need for their exercise ceases only with the life of the organism. The centres which represent the muscles by means of which the trunk is kept erect and balanced upon the pelvis are accessory if compared with those mentioned above, but are fundamental as compared with those which represent the muscles of locomotion. The muscles of the trunk are called into fuller and more frequent play as soon as the child ceases to go on all-fours, and it must then learn, after a fashion which may exigently demand correction or further training later on, to co-ordinate the movements of its limbs with those of its trunk. The child learns to flex its thigh upon the body, the leg upon the thigh, and to elevate the heel from the ground considerably earlier than it can raise its toes so that the foot shall swing clear of the ground and it be enabled to begin another

step. What folly it would be to try to teach a toddling infant to run or jump or dance!

Similarly, the training of the hand and fingers should not only be preceded, but accompanied, by the exercise of the muscles of the fore-arm, arm, shoulder, and trunk. You shall not gather ripe manual cunning from a limb whose trunk attachments are undersized, untrained, or deformed. This fact points to the danger of exacting genuine manual training from young pupils, especially if it be divorced from its proper adjuvant and corrective general gymnastics. It is simply impossible to make any technical drill, such as wood-turning, penmanship, singing, piano exercises, or even the manual of arms, meet the proper ends of bodily education either for children, adolescents, or adults. Technical training, appealing as it does to the most accessory mechanisms, should be grounded on general hygienic and educational training, should not be pushed at too early a stage, and should be left, where it belongs, in the hands of special trainers.

Pastimes, out-of-door sports, and systematic gymnastics are the forms of exercise which yield the best results in the physical training of school-children and college-students. The plays of the kindergarten, the athletic sports to which British and American youth are so devoted, and the systematic gymnastics of the Swedes and Germans have all developed from one germ—from healthful play: the vital energy of this germ is found in the universal and ineradicable impulse of all healthy children to play. The children of every generation, no matter how prim or sour or ascetic their parents may be, are always playing animals. That it is so is a most fortunate thing for the race: were it not so the victims of war, pestilence, and education, and of that voracious monster that men call business, would be vastly more numerous than they are.

In the athletic sports of young men we see the highest and fullest expression of the play instinct. The essential difference between athletics and gymnastics is one of aim. The aim of athletics, unless of the illegitimate professional sort, is pleasurable activity for the sake of recreation; that of gymnastics is discipline or training for pleasure, health, and skill. We have but to compare the aims, methods, and results of each, and to call to mind the characteristics of the nations which have affected athletics on the one hand and gymnastics on the other, to perceive that gymnastics are more highly developed and present more features of educational value. Gymnastics, as compared with athletics, are more comprehensive in their aims, more formal, elaborate, and systematic in their methods, and are productive of more solid and considerable results. Gymnastics have been most popular and general among the most highly-trained nations, such as the Greeks of old and the Germans of to-day. The most athletic and, at the

same time, one of the most ill-trained of modern nations is the British. I mean simply this, that an Englishman believes, and acts upon the belief, that you come to do a thing right by doing it, and not by first learning to do it right and then doing it; whereas, the Germans leave little or nothing to the rule of thumb, not even in bodily education. German gymnastics embrace three well-marked fields or departments —viz. popular gymnastics, school gymnastics, and military gymnastics. The organization of the last two departments is maintained and controlled by the government for strictly educational purposes; while the Turn Vereine, as the popular gymnastic societies are called, are voluntary associations of a social and semi-educational, but wholly popular and patriotic, character. The fondness of the German people for gymnastics is almost as marked a national trait as is the liking of the British for athletic sports. The German system of gymnastics has been most highly developed in Prussia, where not far from a fifth of the population is undergoing systematic physical training at the present time under the combined agencies of the schools, the army, and the Turn Vereine. In Switzerland and in Norway and Sweden you will find school and military gymnastics, especially in Sweden, quite as fully developed as in Germany, and popular gymnastics not so much so.

I have no disposition to disparage athletic sports. I would that they were more general and better regulated than they are in our country. I believe that they are valuable as a means of recreation; that they conduce to bodily growth and improvement; and that their moral effects are of value, since they call for self-subordination, public spirit, and co-operative effort, and serve to reveal the dominant characteristics and tendencies as regards the temper, disposition, and force of will of those who engage in them. But they bear so indelibly the marks of their childish origin, they are so crude and unspecialized as to their methods, as to render them inadequate for the purposes of a thoroughgoing and broad system of bodily education. It is well to promote them, and it is becoming increasingly necessary to regulate them, but it is unwise and short-sighted to consider them as constituting anything more than a single stage in the best bodily training.

One of the main defects of our school-training hitherto is found in the fact that lessons and tasks are set which involve the activity of the accessory parts of the nervous system before its fundamental portions have been properly built up and trained. The result of this inverted and unnatural order of teaching is seen in myriad forms of nervous disease which find expression in St. Vitus's dance, grimaces, spasms, convulsions, and other forms of disordered muscular action, as well as in the protean forms of headache, nervous exhaustion, and mental derangement so common nowadays amongst sedentary people and brain-workers. For the purpose of forestalling such results I would encourage

games for boys and girls during their school-life, and would require of them compulsory attendance upon instruction in gymnastics, drawing and modelling, and in the elements of certain selected handicrafts for general educational purposes.

Dr. Ross, in his work before cited, has expressed himself so admirably with regard to the place of physical training in the education of children with neurotic tendencies that I quote his words in full:

"The children of parents who manifest a predisposition to severe nervous disease, as hysteria and epilepsy, are frequently not merely quick in their perceptive faculties, but are also often possessed of great intellectual powers, and much of their future happiness depends upon judicious mental training in youth. The children of such families ought not to be subjected to any severe mental strain during the period of bodily development, or be allowed to enter into competition with other children in the mental gymnastics which are so fashionable in our public schools. On the other hand, regular, graduated, and systematic exercise in the form of walking, riding, gymnastics, and calisthenics does a great deal of good by strengthening both the muscular and nervous system. Everything which tends to develop the muscles of the lower extremities and trunk, and indeed all muscles engaged in executing the movements common to both man and the lower animals, tends also to develop the fundamental part of the nervous system; and a good sound development of the fundamental is the first prerequisite to a well-balanced development of the accessory portion.

"The order of the development of the nervous system in the race has been from the fundamental to the accessory portions; and no one can reverse this process with impunity in that further development of the individual which constitutes education in its widest sense. Yet until a few years ago the natural order of development was reversed in the education of youth, and especially in female education, so far as this could be accomplished by human contrivance and ingenuity. The natural order of development was indeed observed so far as to allow the child to acquire the power of walking prior to that of other accomplishments, but the care of the infant had not yet been transferred to the professional trainer. No sooner, however, had what is technically called education begun than the professional trainer began to exercise the small muscles of vocalization and articulation so as to acquire the art of reading, the small muscles of the hand so as to acquire the art of writing, and in the case of young ladies the still more complicated movements necessary in running over the keyboard of a piano, while little attention was paid to the development of the larger muscles of the trunk and lower extremities, upon the full development of which the future comfort of the individual depends.

"In the education of youth in the present day the laws of develop-

ment and physiology are not so openly violated and defied as they were a few years ago; but much remains to be done in this respect, and especially in the education of the children of families who manifest a neuropathic tendency. In the children of such families the greatest possible care should be taken to develop the fundamental actions, inasmuch as a sound development of these involves a stable construction of the fundamental part of the nervous system—a process which makes the latter to offer greater specific resistance to the paroxysmal discharges from the later-evolved centres of the accessory portions which underlie hysteria, epilepsy, and even many of the psychoses. The process of educating the accessory system, and especially the higher centres of that system, in young people with a neuropathic predisposition should be regular and systematic; habits of mental scrutiny and self-examination—which, unfortunately, too many religious teachers deem necessary for the welfare of the soul—ought to be discouraged. In one word, education should be made as concrete and objective as possible."

Modern science lays stress upon the idea that children and youth are the immature young of the human species, and are, therefore, subject to the laws of organic evolution. Accordingly, the problems of education are more and more coming to be considered as problems in evolution—problems in growth and development.

Growth and development are the cardinal characteristics of the stage of immaturity; but since development waits upon growth, the two processes vary in rate and amount in different parts of the stage. Nor should it be forgotten that the several somatic and special mechanisms of the body differ in respect to the order and rate of their growth and development. Not till the significance of those differences is recognized and heeded will education become completely natural and rational. The stage of immaturity in the human being may be roughly divided into three equal periods of eight years each. Both growth and development proceed during each period, but growth preponderates in the first and second and development in the third period. The salient features of each period, and the forms of exercise most appropriate to them, may be grouped as follows:

First Period, from Birth to the Close of the Eighth Year.—The whole body grows rapidly in the first two years of life, more particularly in the first; but it is the "immense growth of the brain," which attains its full weight within a few ounces in the eighth year, that chiefly signalizes this period. In the domain of development the sensory organs take the lead and reach a relatively high degree of perfection; though certain of the most essential neuro-muscular mechanisms concerned in the co-ordination of relatively central movements also undergo active development; *e. g.*, those concerned in

equilibration, locomotion, and vocal utterance. The child is imitative, inquisitive, and acquisitive; but his perceptive powers and his memory develop faster than his powers of discrimination and expression. During this period sensory education may safely be diversified and somewhat specially emphasized; but motor education should be of a more general and elementary character.

Strenuous or exacting "drill," especially of the intermediate and accessory mechanisms, is contraindicated for the child. Both games and gymnastics yield valuable results if they are intelligently selected and conducted; but the first should be easy and simple, and the second elementary in their character.

Second Period, from the Beginning of the Ninth Year to the End of the Sixteenth Year.—This is distinctively the period of most rapid growth in height and weight. In increase in weight the muscles play the leading part. Motor co-ordinations reach a higher degree of development than was possible during the preceding period, though they are not fully perfected till adolescence is nearly completed. "The process of perfecting motor co-ordinations cannot be said to be complete," says Dr. Clouston, in his *Neuroses of Development*, "while the awkward, ungraceful motions of hobbledehoyhood last, and until we reach the grace and poetry of body motion of the maiden of twenty-three and the dexterity, force, and swiftness of co-ordination of eye, hand, and body seen in the male cricketer or lawn-tennis player of twenty-five." As Dr. Clouston has pointed out, one of the most marked features of this period is the co-ordination of motion and emotion.

In this period the individual diverges from the mental condition of childhood and takes on the distinctive characteristics of youth or maiden. The changes in body, mind, and character which result from the establishment of puberty are profound and lasting in both sexes, though in this period they transpire more rapidly and proceed further in the gentler sex, since females in comparison with males are precocious in growth and development.

Self-consciousness is awakened, self-confidence is quickened, and new impulses, appetencies, and ambitions arise which prompt the adolescent to try all things and everybody. The child yields to authority and accepts dicta, and even *obiter dicta*, with comparatively good grace; but the youth demands reasons and must be convinced, or at least persuaded, by his teachers and governors; he may be led, but he resists being driven. Educational methods, therefore, particularly during the second half of this period, should savor more of incitement than compulsion. The formal education of the great majority of public-school pupils terminates in this period, since so soon as they are fairly well-grown their services become marketable.

Those who are destined to the ruder forms of labor or the humbler crafts and occupations enter the lowest ranks of wage-earners, while as yet the privileged youth, selected by their parents or by circumstances to engage in pursuits which demand special aptitude or technical training, are still too undeveloped, in most instances, to make rational choice of a vocation, much less to engage profitably in professional pursuits or the higher crafts.

On the whole, since the period of most active growth appears to be followed by one of comparative exhaustion, when the organism is peculiarly susceptible to disturbing influences, the second may be considered, from the hygienic standpoint, as the most critical of the three periods. Exhausting constitutional disease, excessive mental or bodily exertion, underfeeding, ill-judged deprivation of muscular exercise, may readily lead to irremediable stunting or enfeeblement, especially in those who are city-born and city-bred. If physical education be neglected or misdirected during this period, if it be deferred till a more convenient season, it cannot accomplish its perfect work, either as regards the promotion of health or the development of the motor powers of the brain.

The main general departments of physical education should be systematically availed of—*i. e.*, both gymnastic training and athletic pastimes should be given a prominent place in the school curriculum, and the forms of exercise selected should be more varied, complicated, and difficult than those employed in the previous period. But the time for attempting feats or contests that demand extraordinary strength, endurance, or skill is not yet.

Third Period, from the Beginning of the Seventeenth to the Close of the Twenty-fourth Year.—This, the period of established adolescence, is distinctively a period of development—of character as well as of bodily and mental faculty. The life of the race begins to be reflected in the life of the individual, to whom a wider and higher range of activities is opened through the development and perfecting of his higher fundamental and accessory mechanisms. Emotion is co-ordinated with self-chosen aims and ideals; self-directed actions increase in number and effectiveness, and the individual is prepared by special forms of technical training to enter upon his life-work as an adult member of society.

The muscles, which are to serve as the executive instruments of the brain, do not attain full growth till toward the end of the second period. Then, when both brain and muscles are fully grown, neuro-muscular development enters upon its most active and important stage—*i. e.*, in the third period. Measures that directly or chiefly promote growth are mainly hygienic measures, and measures that chiefly promote development, in distinction from growth, are mainly

educative. A wise combination of hygienic and educative measures is called for, both in the sensory and motor education of the individual, during each and all of the three periods; but as regards physical education, during the whole of the first and the first half of the second period hygienic measures should preponderate; while during the last half of the second and the whole of the third period educative forms of exercise should be assigned the leading part, provided that practically normal growth and sound health have been secured to start with.

Attempts at *tours de force*, trophy-winning, and record-breaking, which would be ill-judged at an earlier stage, may now be profitably encouraged—within reasonable limits—in the case of well-developed and well-trained gymnasts and athletes. Doubtless there are valid objections to rampant athleticism. Nevertheless, the predilection of collegiate youth for athletic sports and contests may be justified as natural and fitting by the teachings of neurology and psychology, if once it be admitted that the development of mind and character, as well as that of brain and muscles, is subject to the laws of evolution. The average collegian, if a healthy animal, is apter at expressing himself fully in terms of muscularity than in terms of mentality. Intellectual maturity comes later, unless arrested development supervenes. It can hardly be considered a misfortune that in the heyday of youth the sons of civilized men tend to exhibit in their games something of the hardihood, daring, and contentiousness which characterized the principal pursuits of their primitive, beast-hunting, war-making ancestors.

My plea is, that inasmuch as physical training enters of necessity into the training of every school-child, every apprentice, every recruit, those who undertake to train scholars or craftsmen, artists or authors, should see to it that mental training is not pursued to the neglect or detriment of bodily training; that each kind of training should be given its proper place in the compulsory curriculum of our public schools; and that bodily training should be given in appropriately fitted places, by specially trained and well-qualified teachers, in a systematic, well-ordered, and rational way.

No comprehensive system of physical training can be considered safe or rational whose exercises are not adapted to meet the varied and varying wants and requirements of the individuals to be trained in respect to their sex, age, health, strength, mental capacity, and calling in life. The results which should be secured by such a system are briefly these: Easy and graceful carriage of the head and limbs; a broad, deep, and capacious chest in which the heart and lungs, developed to their normal size and strength, shall have free, full, and regular

play; square shoulders; a straight back; fully-developed and well-rounded limbs; and the power to execute with ease, precision, and economy of force such movements as are involved in the simpler exercises of strength and skill and in ordinary gymnastic and athletic feats. Given sound organs, a well-knit, vigorous frame, ordinary intelligence and docility in a pupil, and your technical trainer will accomplish a hundred-fold more than he otherwise could, whether his business be to train up a professional fencer or ploughman, an actor or an acrobat, a singer or wood-carver, a penman or an elocutionist.

It is beyond question that the Grecian gymnastics and athletics affected chiefly the fundamental neuro-muscular mechanisms. The same is true of the martial exercises of the ancient Gauls and Teutons and of the popular sports of their descendants. Wrestling, running, leaping, casting the stone or hammer, tossing a beam or tree-trunk, hurling the spear, and cudgel and sword-play, are not only the most widespread, but also the most primitive and ancient, of European popular sports. Nor should ball-games be omitted from this category. Of popular sports in general we may say that they promote the more massive bodily virtues of strength, endurance, and speed, while dexterity, address, sleight-of-hand, finesse, quickness and accuracy of eye and hand require more specialized and complicated forms of exercise for their development. In other words, athletic sports are insufficient for the purpose of giving a complete training to the fundamental and accessory groups of muscles, and require to be supplemented by such drill as is afforded by the systematic gymnastics of the Swedes and Germans. For purely educational ends, no system of physical training has yet been devised which is superior to the Swedish school gymnastics.

Mechano-therapy has been, and still is, for the most part, employed in an empirical way. One branch of mechano-therapy—viz. massage—may now be said to constitute a part of rational therapeutics, since physiologists, pathologists, and clinicians have conjointly accumulated a sufficient body of facts to explain its working and effects, and to make clear the principles in accordance with which it should be resorted to or avoided as a remedial agent. Physiology, in its modern development, has thrown much light on the nature and uses of general muscular exercise, but until physiologists and clinicians shall have given at least as much attention to general exercise as they have to massage, muscular exercise must remain a part of empirical therapeutics, even though there be a considerable and increasing number of men who are capable of making rational use of it. The growing tendency of some of the wisest and most successful physicians to supplement the use of drugs by means of hygienic and dietetic measures is a hopeful one, and may ultimately lead to a recognition and deter-

mination of the rational uses of exercise in the treatment of disease. At the same time, it is idle and unprofitable to claim too much for, or to expect too much from, such procedures as bathing or exercise, since they are at best adjuvants only, and can never supersede the use of medicaments.

Speaking broadly, it is hardly possible to discriminate accurately between the hygienic and therapeutical effects of exercise; at any rate, when we have to do with certain general disorders, such as debility, anæmia, neurasthenia, hysteria, obesity, and insufficient muscular development. Exercise is as necessary as sufficient and nutritious food for growing children, in health, in order to secure normal growth of structure and normal development of function in the various tissues and organs. Similarly, adolescents and adults require a certain amount of muscular exercise to prevent their organs from dwindling in size and losing their full powers of functional activity. In such cases exercise, if not excessive or ill-timed, is to be considered a hygienic measure. In ill-nourished, weakly children, on the other hand, in convalescents recovering from acute or chronic illness, in many cases of brain-fag, in some forms of mental derangement, exercise may be employed as a general tonic or prophylactic.

Attention was called above to the opinions of Dr. Ross with regard to the place of physical training in the education of children who inherit neurotic or insane tendencies. It may here be mentioned that the directors of several American asylums for the blind, for feeble-minded, for deaf-mutes, for inebriates, and the insane have introduced one or another form of physical training, not only as a means of promoting the health of those under their charge, but for the avowed purpose, as well, of awakening, strengthening, and refining the activities of the brain and sense-organs. Special teachers of gymnastics—and in some cases specially-erected gymnasia also—are now to be found in many such institutions.

The late Dr. E. Seguin of New York was an ardent advocate of muscular exercise as a factor in what he denominated physiological education. As is well known, he was among the first to show that idiots could be educated. In his work on *Idiocy*, Seguin gives a circumstantial account of the manner in which physical exercises were employed to awaken and confirm intelligence nearly forty years ago in the Institution for Idiots established under Dr. Wilbur at Syracuse, N. Y., in 1854. Seguin's views and experience may be cited here with profit, since they relate not only to the subject under consideration, but also afford concrete evidence in favor of the somewhat theoretical and schematic statements quoted above from Ross, Crichton-Browne, and Mercier.

In his "Report on Education" (second edition, 1880), Seguin, in

speaking of English teachers of idiots, avers that "they do not seem to attach sufficient importance to that period of the education which corresponds in the idiot with what I will venture to call the *building mania* in the infancy of peoples. If we can make the pupil enter upon this period, and if we awaken that taste in him, he may be, through it, carried to the conception of higher combinations of parts to form a whole, besides acquiring, in various attitudes, operations, and manipulations of the *material*, the physical aptitudes comprehended in the word 'dexterity.'

"At the threshold of the school proper they do not seem to understand that filiation, and therefore that rational progression, which gives precedence to the systematic movements of the body over drawing, of drawing over writing, of writing over reading; it is almost the reverse order that obtains, unless, as in the majority of instances, there is no order at all, either practised or suspected. . . . . At the bottom of success in all the arts and of all artisans is the precision of touch, which is a guide to our natural or mechanical instruments of execution. Since the muscles of the life of relation obey the nervous impulses, results of impressions either actual or previously recorded, the richer the store of sensory impressions the more true and effective will be the work done by the skilful play of the muscular contractions. . . . . But in that *touch* there is more than sensitive *tact:* there is also a force prompted by a muscular lever.

"Gymnastics and sports are instituted to develop this power; many schools have them; all should have a gymnasium; but, strange enough, hardly any one suspects its *raison-d'être.* To grow immense packs of muscles? No, but to develop parts of the body weakened or ill-nourished, to harmonize several organic and all the motor and local functions, to put the essential apparatus, as lungs, heart, skin, in working order, and to discipline every muscle of the life of relation to obey the dictates of the intellect from the brain, of the will from the sympathetic and spinal cord. This should supersede the gymnastics, boating, racing, etc. instituted to make muscle for the sake of muscle, producing clowns, amusing enough, colossi, achronological pachyderms, extinct knighthoods which cannot show on their blazon one noble though comical Don Quixote for a hundred greasy Sancho Panzas. The gymnastics we favor and demand is that which calls into useful activity the muscles controlled by the sentient and motor nerves—every lever which can be commanded by a refined intellect; this training to be done from the periphery to the centre, from the centre to the periphery, be it imitated or willed; to develop the primary elements of intentional personal *activity* and of objective *aggressivity*, giving a meaning to every muscular contraction." So much for Seguin's views in *Physiological Education*—expressed, be it said, by means of a somewhat antiquated

terminology. His article entitled, "Psycho-physiological Training of an Idiotic Hand," in the *Archives of Medicine*, October, 1879, shows how he applied his theories. The case reported is that of a boy, eight years old, rendered idiotic by infantile convulsions. The boy had been under the training detailed by Seguin for one year:

"The hand of R—— was small, the nails short and brittle, fingers as if unfinished—no power, no skill, only automatic movements, mainly from the wrist. To make R——'s hand act on command was at first out of the question. He could not put it or the fingers in any given attitude. He could obey the movements of elevation and abduction of the arm, but not always nor with anything like precision.

"*Therefore his teacher had to begin the training of the hand from the shoulder by movements which, starting from the elevators of the arms, would involve successively the muscles of the arm and hand.* Thus, by a series of operations whose willed or obedient starting-point descended gradually from the spine, the child became capable of moving his hand and fingers by imitation, at first, and *proprio motu* for simple willed operations later. . . . . The movements commanded to R—— were those commencing nearer the spine, the trainer gradually extending the operations of the will to the groups of muscles approaching the extremities. Thus the limb in training not only became capable of a few willed movements of totality, later applicable to a great number of operations and convertible into smaller movements of the farther extremities, but the mind, being drilled to be carried over regions previously ruled by automatism alone, extended its dominions and circulated as if at home from the great centres to the most delicate groups of sensitive and contractile tissues at the periphery.

"To illustrate the difference of ability of the hand during these forms of training according to the origin of the impulse, I notice the freedom of the hand of R—— when driving nails in a board with a hammer—a movement of the arm and wrist—as against the sliding of a pin he holds with the intention of piercing holes in a paper, with but rare success—movement confined to the last phalanges of two fingers.

"Has he learned to read, write, and the sequel? No: his hand has learned to help himself, to amuse himself, to not bite itself, nor to slap his friends, though it is yet sometimes subject to its automatic agitations. His tact has been cultivated to the point of being conscious of the ordinary variations of the temperature, of water, food, etc., and of recognizing and naming (without the help of sight) about fifty things by their shape, and quite as many by their texture. His eye—after his touch—has been drilled to appreciate the typical forms in substance at first, and later painted, delineated, and hardly indicated; then to cut the same out of paper, etc."

The following year much attention was given to training R——'s eyes in correlation with his hands, and as a result of the training initiated in the education of his hand, above detailed, R—— was finally enabled to enter a school for ordinary children, and to do fairly well at his lessons.

Although systematic exercise has been accorded for many years a prominent place in the course of treatment and training of institutions for defectives in various European countries, notably Germany and Sweden, it is to an American institution, the New York State Reformatory, at Elmira, N. Y., that we owe the proof of the efficacy of physical training as a helpful means of reforming felons. In many respects the Elmira Reformatory, founded in 1876, is perhaps the most original educational institution in America. Its inmates consist of male felons between sixteen and thirty years of age, serving their first sentence. All sentences to Elmira are indeterminate—that is to say, no prisoner may be confined for a period exceeding the maximum term of imprisonment provided by law for the crime of which he has been convicted. But it is possible for a prisoner to gain an absolute release in about eighteen months from the time of entering the reformatory, though he may have been convicted of a crime punishable under ordinary circumstances with imprisonment for a term of years. To accomplish this is no easy task, for the conditions of release, which is always on parole for six months at least in the first instance, are—that the inmate shall earn perfect marks for twelve consecutive months in "conduct," "labor," and "school;" that he must gain the confidence of the general superintendent and managers; and that previously to his release "some definite, permanent, suitable employment" shall be arranged for by his friends or the management of the reformatory. If a paroled prisoner gives satisfaction to his employer and the authorities of the reformatory during the period of his parole, he may then secure his absolute release and return to civil life without loss of citizenship. 9 is a perfect mark for a month; failure to earn a 3 in either conduct, labor, or school-work entails a new start, as no one is admitted to parole who has not twelve consecutive 9's to his credit. Of the 4550 prisoners received up to September 30, 1890, the number paroled was 2611. It is claimed that about 70 per cent. of those who have been released from the reformatory have not relapsed into crime. The average detention before parole was twenty-one months.

In June, 1886, at the suggestion of Superintendent Brockway, Dr. H. D. Wey, the physician of the reformatory, formed an "experimental class in physical culture." The class was composed of dullards who for a year or more made had no appreciable progress in their school-work, and were likewise behindhand in their labor-tasks. The object of the formation of the class was "to ascertain if physical culture, as com-

prised in frequent baths, massage, and daily calisthenics, would not result in a partial awakening and stimulation of dormant mental power. Increased mental activity, rather than muscular development, was to be the gauge of the success or failure of the experiment." Eleven men, ranging from nineteen to twenty-nine years of age, were subjected to the conditions spoken of above. They were released from shop-work during that period, but were carefully schooled. The course of procedure finally adopted was to give the class two hours or slightly more a day of practice in "setting-up" exercises and in a dumb-bell drill, and each man had three baths a week, followed by "bath-massage." The members of this class were not sickly, ill-nourished specimens, nor could they be classed with those who are technically termed weak-minded: they were simply coarse, stupid, insensitive, unambitious dullards imprisoned for felony.

The five months' experiment proved a striking success. The men improved not only in physique and carriage, but also in mental power and self-control. The average marking of the class, according to the school register, was, for the five months in question, 74.16 out of a possible 100, whereas the corresponding mark, for the five months immediately prior to the beginning of the experiment, was 45.25. Comparison of the record of the class for the six months preceding the five months of physical training with its record for the six months succeeding that period shows that the improvement gained was not of a transitory character. In the first period the general average on the scale of 100 was 46, and in the second 71; while the average marks, 3 being the scale in conduct, were—$2\frac{1}{2}$ and $2\frac{1}{3}$ respectively, and in school-work $1\frac{3}{22}$ and $2\frac{9}{30}$ respectively.

Owing to the successful results obtained by Dr. Wey in the case of the experimental class, and of several subsequent classes subjected to similar treatment, the New York Legislature appropriated funds sufficient to provide the Elmira Reformatory with a suitable gymnasium and bath-house. These establishments, costing when completed about $15,000, have been in use since March 20, 1890. The two establishments are included in one building. The gymnasium hall, which is 83 by 102 feet, has a suspended running track, and is fully furnished with apparatus, including a set of Dr. Sargent's developing gymnastic machines. The bath-house contains two "hot rooms," a massage-room, and a swiming bath 16 by 45 feet. The main portion of the inmates at Elmira are not subjected to gymnastic training; they are, however, organized as a regiment, are subject to military regulations, and are regularly and strictly exercised in military drill.

"The gymnasium," says Dr. Wey in the report of the reformatory for 1890, "has come to be, for certain classes of defectives, a place of preparation for the schools of trades and letters, and *an auxiliary to*

the hospital. 128 men have received treatment in the gymnasium. Of this number, 43 comprised a class in training at the time the building was completed, and the balance, 85, were subsequently selected [out of a total of 1080 inmates]. The 85 men were placed in training for the following purposes:

"1. Physical renovation and betterment, 63.

"2. Intellection, 14.

"3. Ethics, 8.

"The first class comprised boys who were received into the reformatory poorly nourished and anæmic; those reduced through personal vices and physical disturbances incident to puberty; the shop-worn and subjects of actual lesion or disease. For the first three varieties physical training is a reconstructive measure. For the third variety, subjects of certain lesions, an improved nutrition, resulting from increased powers of assimilation and waste, operates more favorably than hospital care and chemical therapeutics. Selections have been made for functional cardiac trouble due to nervous enervation, subacute bronchitis, epilepsy, struma, incipient pulmonary disease, and cutaneous affections, as acne, seborrhœa, and ichthyosis.

"The effect upon the dullard of the bath, exercise, and dietetics quickens and widens the scope of motor and sensory functions, draws out latent energy, and establishes a degree of susceptibility to classroom influences. Thus, qualities of cerebration become reasonably certain that were possible, but not probable, during a continuance of the subject's vegetative state.

"Those selected for ethical improvement were instances of low and faulty bodily conditions operating to the detriment of order and behavior."

The Elmira gymnasium is not due to an attack of what Dr. Seguin happily styles the *building mania.* It owes its existence to a firm conviction, born of experiment and reflection, that systematic muscular exercise is capable of building up and strengthening the brain and nerves, as well as the organs of locomotion, nutrition, and excretion. It is devoutly to be desired that a tithe of the American schools and colleges that have fallen in with the present fashion of building gymnasia should profit by the example of Elmira, and order and administer their departments of physical training in accordance with sound hygienic and pedagogical principles. Not a few college presidents and boards of trust have suffered from acute attacks of what may be termed *Pruritus ædificandi,* but the instances are extremely rare in which they have shown any symptoms of *Furor pedagogicus,* so far as physical education is concerned.

Dr. Wey's assertion that the Elmira gymnasium is an efficient auxiliary to the prison hospital is worthy of careful consideration on

the part of the governors of our large general hospitals. As has been mentioned, many institutions for defectives have adopted gymnastic procedures as a part of their course of treatment and training, and a considerable number of private orthopædic institutes, having more or less complete gymnasia, might be added to the list. But I have yet to learn of any large general hospital, either in this country or in Europe, which numbers among its resources a well-equipped general or medical gymnasium. It seems to me high time that those in charge of medical schools, public hospitals, and dispensaries should give serious attention to mechano-therapy in all its branches; should test the worth of the appliances and methods now in use in this field; and should adopt and employ such of them as may stand the test of critical study and well-directed experiment.

Medical gymnastics and massage have been left so generally, especially in this country and Great Britain, in the hands of uncritical and enthusiastic laymen, or of quacks and humbugs, that mechano-therapy is not likely to receive its due meed of recognition, from the profession at large, until some few at least of those who mould medical opinion through their didactic and clinical teachings shall have determined and set forth the actual value of mechano-therapeutical procedures and their proper relations to chemical therapeutics.

It seems a misfortune, or worse, that the profession is as yet unprepared or unwilling to speak with authority on the uses and abuses of exercise. There is already a demand for rational advice in this matter, and that demand is increasing by reason of the rapid spread of ill-regulated forms of violent exercise in school and college circles, the rapid multiplication of gymnasia and athletic clubs, and the growing agitation for the introduction of physical and manual training into the public-school curriculum. While the market is wellnigh flooded with books and articles by untrained "professors" and uncritical visionaries upon "massage," "relaxing exercises," "Delsarte exercises," "rest cures," and other fragmentary and aberrant systems of physical exercise, there exists no complete and satisfactory treatise, in English, upon the nature and effects of exercise, and the laws by which it should be regulated when employed for hygienic, educational, or remedial ends. It would seem that the public must follow for the most part misleading or false guides, so long as medical teachers and writers fail to treat the subject in a thoroughgoing, scientific, and practical way. It is noteworthy, though not inexplicable, that American medical schools and hospitals, which have done so much to improve the education of professional nurses, should leave the training of medical gymnasts and givers of massage almost entirely to half-educated persons or to private adventure schools of gymnastics.

Of national systems of exercise, only the Grecian and the Swedish

present a distinct department of medical gymnastics. Grecian medical gymnastics are chiefly of historical interest, as modern therapeutics have been in no wise moulded by the teachings of Herodicus, Hippocrates, and Galen with regard to dietetic exercise. We need not concern ourselves here with the mechano-therapy of the Greeks and Romans, or that of the Hindoos and Chinese, as the gymnastics and massage now in vogue are essentially products of the nineteenth century, though it is possible to show that they were matters of speculation and experiment in France, Germany, and England during the second half of the last century.

Modern gymnastics have reached their highest development in Sweden and Germany, where for some scores of years they have been systematically employed for purposes of school and military training; but the Swedish *Sjukgymnastik*, or movement treatment, is as distinctly superior for medical purposes to the German *Turnen* as it is to the school games of the English. Swedish gymnastics were first quickened and shaped through the instrumentality of Peter Henry Ling, a Swede, who was born in 1776 and died in 1839. It is said that Ling's interest in gymnastics arose from his having been cured, while a student, of a rheumatic affection in the shoulder through the practice of fencing. He began his public career in 1804 as a teacher of gymnastics and fencing at the Swedish University of Lund. Ling was unquestionably a man of genius. and became renowned not only as the founder of Swedish gymnastics, but as a linguist and poet as well. From the time of its establishment in 1813 until his death Ling was at the head of the Royal Central Gymnastic Institute at Stockholm. Ling, though an ardent student of the anatomy and physiology of his day, never had a medical degree. He seems to have been an acute observer, an indefatigable worker, and an inspiring teacher. He and his pupils succeeded in gaining a large measure of approval and patronage from the public, in spite of the indifference or hostility of the medical profession. Early in his career Ling attracted the attention of Bernadotte, whose friendship and patronage proved of great service to him and his cause.

Ling divided gymnastic movements into four main classes—viz. 1, movements serviceable in the treatment of disease or deformity, or *Sjukgymnastik;* 2, movements chiefly useful in promoting and maintaining a normal bodily development, or *Friskgymnastik;* 3, movements suited to rendering recruits in the army and navy strong, dextrous, and enduring, or *Militärgymnastik;* and 4, movements for giving outward expression to thought or motion, or *Aestetiskgymnastik*. It is a cardinal principle in all forms of the Swedish gymnastics that any given movement of the trunk or limbs has a specific effect upon the inner organs of the body, and that in medical and developing exer-

cises only such movements should be employed as have been shown by experience to produce the effect desired. Great care in selecting movements and strict regard to the manner in which they should be performed characterize the Swedish gymnastics.

Although many of the doctrines enunciated by Ling and his successors at the Central Institute in Stockholm seem mystical and fantastic in the light of modern physiological and medical science, they are entitled to a high meed of praise for their success in proving the practical worth of methodical muscular exercise as a means to reaching certain educational, hygienic, and remedial ends.

The procedures employed by the medical gymnasts comprise active movements, which are simply voluntary movements executed by the patient without assistance; passive movements, or movements of the patient's body or of some part of it by the manipulator; and duplex movements, in which both patient and gymnast take part. Resisted and assisted movements, of which so much is said in massage literature, belong to the so-called duplex movements. The use of passive and duplex movements is one of the most characteristic features of the Swedish-movement treatment. According to a recent law—whose provisions are not retroactive, however—only such persons as pass the examinations set by the Central Institute in Stockholm or by a duly authorized government board will be licensed to practise medical gymnastics, and unless they possess a medical degree they must associate themselves with a physician or act under the direction of one.

The Central Institute has become the most comprehensive and thorough gymnastic school in the world. Its present teaching staff numbers several physicians among its members, as well as several officers of the army, fencing being a favorite branch of instruction; indeed, the majority of its pupils are young officers of the army and navy. The course of study is three years, for women two, the latter being excused from the course in fencing. One must take the full course in order to be graduated as a Sjukgymnast, but may fulfil the requirements of the normal course for teachers of school or military gymnastics in two years. Anatomy, physiology, and the principles and practice of movements are the chief studies. Didactic teaching and practical exercises are combined in the instruction throughout the entire course. Some hundreds of school-children are taught gymnastics by the pupils of the institute. The institute maintains a daily clinic, in which a considerable number of patients receive gymnastic treatment for a great variety of ailments.

Medical gymnastics and massage are frequently used in combination in Sweden and Norway, though the distinction between the two is nowhere more clearly recognized than in those countries. Massage is understood to consist of a few peculiar manipulations, such as stroking,

kneading, friction, and striking. It is frequently practised by persons, including many physicians, who are not gymnasts. The massage movements were described and made use of by Ling among his so-called passive movements, though the term massage is French and has become general in Sweden only within the last twenty years. Still, as is easily shown, Dutch, German, and Swedish physicians have been much more influential than the Swedish gymnasts in winning recognition for massage as a special mode of treatment. The peculiar combination of massage and gymnastics, known as pelvic or Brandt massage, may be cited as a partial exception to the above statement. Major Thure Brandt of Stockholm, a Swedish gymnast of high character and good standing, has employed massage and gymnastics in the treatment of prolapsus uteri, prolapsus ani, retroversio uteri, parametritis, etc., for many years. The Brandt massage is sufficiently rational and conservative to be worthy of study and testing of American and English, as well as Scandinavian and German, gynecologists; but it cannot safely be relegated to ordinary rubbers who work by the hour.

The ordinary medical gymnast is often termed a manual gymnast, for the reason that he employs comparatively little apparatus in his practice, while such simple appliances as he does use do not come under the head of machinery. One of the most notable forms of the Swedish gymnastics is that known as the mechanico-medical gymnastics, or the Zander gymnastics, as it is sometimes called after its inventor, Dr. Gustaf Zander of Stockholm. In the course of the last thirty-five years Dr. Zander, whose mechanical genius is of a high order, has devised some sixty different machines by means of which it is possible to give circumscribed and accurately regulated exercise to almost any particular group of muscles in the body. The principles and aims of the mechanical and manual gymnastics are essentially the same; but it is claimed that the former is a cheaper, more accurate, and efficacious means of procedure than the latter. In a proportion of cases the claim is doubtless just, but it is often necessary to supplement the use of the machines by the employment of a trained hand, especially in affections of the joints. The Zander system has been uncritically described and decried in some quarters as a system of mechanical massage. It is nothing of the kind. Dr. Zander distinctly disclaims having attempted to devise such a system, and has a staff of trained masseurs to give massage in cases properly calling for it. What he does claim is this: that the most important and valuable of the procedures comprised in the movement treatment can be better given by his machines than by manual means.

In the construction of his machines Dr. Zander has made use chiefly of the mechanical principle of the lever, as that is the principle of construction in most of the joints of the human body. By the ingenious

use of counter-weights, and of perforated weights which may be fastened at any desired point on the arms of the lever, the resistance afforded by the machines can be accurately adjusted to the special needs of individual patients. The machines are divided into two main groups—viz. those set in motion by the muscular effort of the patient, and those run by a motor. For the latter series an engine of from six to ten horse-power is sufficient. The first group of machines are termed machines for active movements, and comprise the following series of machines; for arm movements, such as flexion, extension, and twisting at the shoulder, elbow, and wrist; for similar leg movements; for trunk extension, flexions, and twistings; and for trunk-balancing movements. In the second group are machines for passive movements and others for mechanical manipulations, such as shaking, chopping, rubbing, and kneading. Beside these, Dr. Zander has designed a series of machines for the special treatment of scoliosis, of which three are employed to counteract abnormal curvature and rotation of the spinal column by means of carefully regulated pressure, and two are used for accurate measurement of the back and thorax. For distinctly medical purposes the machines for passive movements and for mechanical manipulations are rather more serviceable than the active movement machines, which are more particularly intended for dietetic or developing gymnastics.

As is well known, Dr. Sargent of the Hemenway Gymnasium at Harvard University, has invented a series of some fifty so-called developing gymnastic machines. In the Sargent machines, which are now to be found in most of the newer gymnasiums of the United States, adjustable pulley-weights, running between metal rods as guides, are employed in a great variety of ways. Only active movements are provided for in the Sargent system, which is much better adapted to secure dietetic than medical ends. Although the Zander machines are superior in many respects to the Sargent machines, their cost is so great that their use is not likely to become general in our ordinary gymnasiums. The Woman's College of Baltimore, however, has fitted its gymnasium with a nearly complete set of Zander machines for active movements, being the first institution in the United States to import them.

The Zander Institute and its founder stand deservedly high in the estimation of the medical profession of Stockholm, where the physicians are more inclined toward mechano-therapy than ever before. The institute was opened in 1865, and has since been in continuous operation. It is, however, open for patients only from September 20th till May 15th. It has no boarding-house, hospital, or hotel attachment. In the year 1888–89, Dr. Zander's patients numbered 619; in 1887–88, 549. The following statistical statement will afford an idea of the

scope of the treatment. Patients were treated in 1887–88 as follows:

For anæmia and chlorosis	27
For obesity	13
For nervous affections	79
For heart affections	108
For diseases of the lungs	11
For diseases of the digestive organs	89
For diseases of the organs of locomotion	159
Number taking dietetic gymnastics	63
	549

The success of the Swedish gymnasts, both by manual and mechanical means, in treating affections of the heart has been quite remarkable. In this branch of treatment the Swedes certainly anticipated the so-called Oertel cure for weak and fatty heart. It is so totally foreign to our ideas to prescribe or even allow gymnastics in cases of heart disease that a closer analysis of those cases included in the above table will be of interest. Of 108 cases under heart affection, there were—

2 of angina pectoris,
27 of erethismus cordis,
52 of asthenia cordis,
20 of vitium organicum cordis,
7 of endarteritis chronica.

Dr. Zander has had marked success in treating scoliosis. He has devised an ingenious apparatus for measuring the deviations of the spinal column, and makes constant use of it in checking the results of his treatment. (For an account of Dr. Zander's methods and results see his article, "Om Den Habituela Skolioseus Behandling Medels Mekanisk Gymnastik," in *Nordiskt Mediciniskt Arkiv*, Band xxi., Nov. 22, 1889. The article is in Swedish, but is accompanied by an abstract in French.)

Enough has been said, I think, to indicate that medical gymnastics have entered on a new stage of development—that they are more carefully studied, better understood, and more generally prescribed by medical men in Scandinavia and Germany than ever before. The average practitioner of medicine has neither time nor appliances to devote to the mechanico-therapeutical treatment of the obstinately chronic cases in which he is inclined to prescribe "muscular exercise," "out-of-door life," and other equally vague remedies. Zander institutes, under the guidance and control of regularly educated specialists, would be a help and not a hindrance to the average practitioner in all our large cities. The Zander Institute in Berlin was established by an association of physicians, and the best men of the profession send patients to it.

THE REST-CURE FOR NEURASTHENIA AND HYSTERIA.

By JOHN K. MITCHELL, M. D.

The system of treatment for the varying conditions of neurasthenia, hysteria, and certain nervous troubles by Rest, including in this term all those developments in the direction of passive exercise, full feeding, and isolation, which I shall have to consider in this article, was first publicly described by Dr. S. Weir Mitchell in a lecture published in 1875 in vol. i. of Seguin's series of *American Clinical Lectures*. In 1877, Dr. Mitchell published a more elaborate description of it in an essay entitled *Fat and Blood*, of which the eighth edition was issued in 1900. Dr. William Playfair of London has used the method and written upon it in England.[1] The present article may be considered as an authoritative statement of the most recent developments in this method of treatment.

A few words, first, upon the state which we describe by the vague names of "neurasthenia" and "hysteria."

The terms "neurasthenia" and "nervous prostration" are drag-nets that gather up a motley multitude of ill-defined cases which it would be difficult briefly to define. Neurasthenia is a condition made up of subjective symptoms, yet no one symptom is constantly present in all cases. Nervous exhaustion is a phrase used as equivalent to neurasthenia, but excitation of the nervous system is frequently added to the weakness. Usually we find the nervous system both feeble and irritable, and wherever the manifestations appear, whether they be in the circulation, in the gastro-intestinal tract, or in the cerebro-spinal centres, these characteristics of feebleness and irritability are shown.

However varied the lesser signs may be, certain cardinal symptoms are tolerably constant, which Charcot calls the "neurasthenic stigmata." These are insomnia, headache, enfeeblement of motor-power, dyspepsia, backache (especially in women), and usually brain-fag in some degree. Some of these symptoms are among the earliest signs which the patient observes. To illustrate them very briefly: the *insomnia* is of many kinds and degrees, from mere restlessness and broken sleep to almost total loss of the power to sleep, lasting for weeks or months. This is one of the symptoms which result in endless

[1] *The Systematic Treatment of Nerve-Prostration and Hysteria*,, London, 1883.

evil, owing to the hypnotics and narcotics given in the attempt to overcome it.

The *headache* is usually rather a distress than a pain, and is very constantly present in neurasthenic patients. Its common seats are the frontal, occipital, or nuchal regions, but it may be anywhere in the head, and varies from a heaviness or fulness to an agony. It is made worse by mental effort, sometimes by movement, and may be accompanied with vertigo or with subjective aural or visual disturbances.

Of all the symptoms which neurasthenia presents, the most constant is *loss of motor-power*, an utter incapability of sustained muscular effort. It is absent only in the rare cases which may be described as simple brain-fag. Even the smallest effort is a severe exertion, and results in fatigue out of all proportion to the power put forth, or is followed by vomiting or nausea or diarrhœa. Examination will reveal no paralysis, and the reflexes will be found unaltered or slightly exaggerated.

The *cerebral fatigue* or depression is of the same kind as the muscular prostration. To attempt to fix the attention, even to observe an action or a picture carefully, to talk even of trivial things, results in unusual fatigue of mind and makes the headache worse. The will, the judgment, the moral control, are weakened or in some bad cases perverted, so that a man of a pleasant temperament becomes aggressive, contradictory, and irritable.

Gastro-intestinal indigestion is often thought to be the cause of the neurasthenia. It is certainly very constantly an accompaniment of it, but in many cases it is rather a result of the general depression than a cause. When it exists the most common complaint is loss of appetite, together with an epigastric weight and fulness after eating, followed by eructations of gas, and there is generally troublesome constipation.

Backache, especially in the region of the sacrum, is frequent, and in women the subjects of neurasthenia is almost invariably present.

Besides these cardinal points, innumerable lesser symptoms add to or complicate the diagnosis, and neurasthenia is associated with, and runs into, hysterical conditions, so that no one can draw an absolute line between them. A tender spine, anæmia, ovarian neuralgia, wandering pains about the body, a rapid and irritable heart, troubles of sight and hearing,—all may play their parts in adding to the difficulties of treatment. When to these emotional manifestations or to some of them are added contractures, paraplegias, or disturbances of sensibility, we call the patient hysterical, even though she has no disease of the womb or ovaries.

Having very briefly mentioned the symptoms, we have to consider the varieties of neurasthenic troubles which are proper for submission to treatment by rest. Not all cases of neurasthenia or hysteria are suitable for it. While we have other means at our disposal, it would

be most unwise to order, without discrimination, all "nervous" patients into bed—to force upon them a life which involves separation from their friends, the entire attention of one or more attendants, and consequent great expense. It is only when other ways have failed to cure that we should use the rest-treatment. Further than this, many persons are individually unsuited for it. Until lately, attempts to treat melancholia by this means have had little success, but now I find that judiciously used and in doses, so to speak, suitable to the condition, valuable help may be had from it. In cases with recurring crises of agitation a few days in bed with massage and certain sedative hydrotherapeutic measures will be found to lessen and shorten the attack, but the details of application scarcely belong to a discussion of the uses of the treatment for neurasthenia. In the stuporous forms it cannot be used to advantage, nor in the hypochondriac kinds of melancholia. The habit of too minute analysis of symptoms, of microscopic investigation of their moral and mental condition, to which sufferers from these types of melancholia are prone, is only fostered by the opportunities offered by confinement in bed and consequent inaction. If to melancholia a suicidal mania be added, it is especially undesirable. The depression increases, the loss of appetite usually becomes greater, and the case grows worse, not better. For such cases active exercise is preferable to the passive movements of massage, and open air and movement are better tonics than those of the apothecary.

Acute uterine or peri-uterine disease, while it lasts, contraindicates the rest-treatment. The forms of chronic ovarian disease, for which Battey's operation is usually the only recourse, improve, but seldom recover, though they may improve sufficiently to make surgical interference both easier and more successful. Without such interference they are rarely cured. Advanced Bright's disease or advanced phthisis forbids the use of such a course, but the earlier stages of these diseases may be successfully treated in this way. The cases which do best are bed-ridden hysterical patients suffering from that extraordinary variety of symptoms which make the hysterical panorama—wasted, without appetite, with localized anæsthesias or contractures, morbidly dependent upon sympathy, at once the despair and the livelihood of many physicians. The worse these cases are, the more emaciated, the more hysterical, the more hopeless in appearance, the easier is the cure as a general rule.

The most important indication in favor of this course is found in the patients who have, together with the severer forms of neurasthenia or hysteria, that moral degeneration which is present with them so frequently, and those to whom a too anxious family offer overwhelming attention and sympathy.

In treatment a distinction must be made between the two varieties of neurasthenia to which the French have given the names of "myelasthenia" and "cerebrasthenia." In the latter a man who is prostrated by too much intellectual work or strain, and yet is not physically exhausted, should be treated by having his activity, mental and bodily, measured for him in definite doses. In the former, in which the spinal or medullary centres are in trouble, isolation and rest must be practised. Great anæmia and its congeners, chlorosis and leukæmia, are well treated in this way.

It is hardly necessary to say that a large proportion of neurasthenic patients are women. Indeed, as a rule, rest-treatment is not a means which acts well with men, although there are exceptions. The reasons for this fact are not far to seek. Men are more accustomed to activity. They are less amenable to the necessary discipline, they are more impatient of small restrictions and of slow progress. They seldom get so far advanced in hysterical disease as women, and simulated disease is rare among them. Change is easier to women. They are more accustomed to go up and down physically. A woman loses weight every month with her menstrual flow, and to gain and lose flesh is physiological with the female sex, as it is not with the male. Every physician who has had much hospital experience has noted how much less women are affected by loss of blood than men. Even in hæmorrhages from wounds this is true, and how constantly we see menorrhagia followed by extraordinarily rapid recovery! In a few days the patient will have returned to a nearly normal state, whereas were a man to lose a like amount of blood we should have to help him through a long course of iron and tonics before he could recover; and these tendencies repeat themselves both as to disease and as to therapeutics. Dr. Kleen, in the excellent book on massage which he has recently published,[1] does not find this difficulty, but his patients appear to have been mostly of German origin, and perhaps racial differences may account for the ease with which he succeeded in keeping men in bed for six weeks.

Other important indications for this treatment are found in those conspicuous defects of nutrition which evidently unfit an individual for the use of the muscles. In a person in whom a trifling over-exertion results in a great emotional display no improvement will take place until the nutrition is improved. Harm will be done by making such a person drag himself about, and a more complete breakdown will be the result. Fortunately, rest is a medicine from which little harm can come, so that when we are in doubt we may be sure that we are at least on the safe side by prescribing it.

[1] *Handbuch der Massage*, Dr. Emil Kleen, Berlin, 1890.

One danger, it is said, of putting a patient to rest in bed is that we may not be able to make her get out of bed again when the proper time has come; but this does not seem a very serious danger; at least, it is one which the writer has never experienced, and which no one need fear if the detailed suggestions given later in this article are exactly followed.

The most important element of all is one which is of weight in any treatment of every disease—the personal element. One physician succeeds where another, equally as able, fails. Important as the question of the physician's share in the case may be, it is hardly possible to discuss it here, but it is well to remember that faith is a good adjuvant to even the most active drugs, and faith in the doctor the patient must have, especially in a treatment in which the progress is often so slow and the gain from time to time so little apparent.

The usual beginning of the cases needing rest-treatment is in some exhausting physical or mental strain. Sometimes an illness from which the patient has never entirely convalesced is the starting-point, or a local uterine or ovarian trouble. The patient presently grows pallid, wastes, loses appetite, or, if she eats, her food seems to do her no good. The smallest exertion is followed by disproportionate fatigue. The effort of keeping up social relations leaves her daily more and more exhausted. She begins to sleep badly, has indigestion, is constipated, and is incessantly becoming feebler. If she is of an emotional nature, this tendency becomes more and more dominant until her emotions rule her. Even if she were previously not emotional, she presently becomes so. "The moral degradation which such cases undergo is pitiable. The result is to cultivate self-love and selfishness, and to take away by slow degrees the healthful mastery which all human beings should retain over their own emotions and wants." A physical examination of such a case will perhaps disclose no organic changes. A trifling exertion excites the heart unduly. If there is great anæmia, a hæmic murmur may be heard over the heart at the base. A tender spine, tender ovaries, and asthenopia are often found, but further than this we can observe little wrong. An examination of the blood reveals the ordinary features of the different grades of anæmia—diminished hæmoglobin and a lessened number of corpuscles—but for the host of aches and pains of which the patient will speak no adequate physical causes can be found.

What shall we do with such a case? The sufferer has run the gauntlet of tonics, has been stimulated with alcohol, has been depressed, and had her digestion upset with bromides and perhaps with opium; she has tried without success to secure sleep by chloral or other hypnotics; she has been through water-cures and sanitariums; she has tried Christian science and skepticism.

An endeavor will be made in these pages to describe the method of handling such cases, so that a physician with no previous experience of it may discover how to apply this treatment to the bettering of this melancholy array of symptoms. The means to be used consist of isolation, rest in bed, passive exercise, certain forms of diet, electricity, and, in some instances, of hydropathic measures. How far these means should be modified in different cases will be pointed out under each head. It may be said that during cold weather is the best time for applying this treatment, but hot weather, unless there is excessive heat, need not forbid it. Women should begin treatment immediately after a menstrual period.

Isolation.—The first point to be considered in detail is that of seclusion. No other single feature is of such importance; to no other is it so difficult to secure consent. Even when the patient is willing, the family sometimes are not. It is easier to seclude a patient away from home, but if any success is to attend upon the application of this treatment, somehow the patient must be separated from friends and relatives. Naturally, in a patient's own house this is not easy. It seems hard to a mother or sister that she must be kept upon the far side of the door from the invalid, and not allowed to see her for five minutes; but in neurasthenic and hysterical patients the sympathy which they extract from those who surround them is a food which nourishes their disease. Then, too, this isolation is useful from the total change of moral atmosphere, and from the fact that as the patient grows better she is more and more anxious to escape from the enforced seclusion, and adds her own efforts to those of the physician and attendants.

Cases of myelasthenia, of purely physical prostration from overwork, from hæmorrhage, or from nervous breakdown where there is no hysterical element, may be handled in their own homes, and need not be so entirely separated from their friends. But the neurasthenic, the hysterical, the morbidly fanciful patient, or the one with simulated disease should be rigorously separated from all her acquaintances, away from her family, receiving no letters and sending none. There is another reason why this seclusion is useful. By it one is enabled to gauge the amount of the emotional element in the case—to see how far it is due to the patient's own disposition, and how far it arises from or is increased by her surroundings. If the disease is simulated, she will soon find the audience too limited for the successful production of dramatic effect.

As to the place in which to treat the patient, the best one of all is either a well-managed boarding-house devoted to such uses or a good private hospital. Such cases do not do well in a hospital ward, and even in private rooms in a general hospital it is for many reasons rare

to meet with success. If a patient is placed in a private room of a general hospital, it is well to direct that the resident physician shall make but one visit daily, in order that she may not have this addition to her audience.

For any person absolutely at rest in bed a nurse is needed. In a hospital one attendant can care for five or six persons, as she is always within call, but in a private house it is best to have a nurse devoted entirely to each patient. Besides this attendant the patient will see only the doctor and the person who does the rubbing which is necessary.

Too much consideration cannot be given to the selection of a nurse. Now and then these cases can be carried through with the aid of an unusually firm and intelligent relative as a care-taker, but the nurse should be a stranger to her patient if this is possible; and should the patient come into the physician's hands with a nurse accompanying her, it is usually best to discharge this nurse.

One of the first qualifications of a good nurse is youth. Even experienced and scrupulously painstaking attendants lose, as they grow older in their business, that enthusiasm which is the prerogative of youth, and unless they are unusually conscientious this lack is not well replaced by increased experience. But youth, of course, is a relative term, and there are occasional nurses who seem never to grow old in this way. Quite beyond the qualities useful in a nurse for ordinary acute cases, a woman who is to have to do with hysterical patients must have keen observation, tact, discretion, intelligence, and a certain delicacy of feeling and of manner, or else the sensitive nerves of the patient will certainly revolt. She must be observing, for much of the physician's knowledge of the case and its peculiarities will depend upon her report. She must have discretion enough to know when to tighten and when to relax the reins of discipline—when to yield without giving up, and when absolutely to refuse to bend to the numberless fancies of her patient. Over-harshness will perhaps produce worse effects than too easy yielding. The nurse must remember that in enforcing discipline she should never come to an open fight with the patient; if she does, it has to be reported to the physician, and the nurse is put in the position of a spy and an enemy by it. Let her drop upon the doctor's shoulders the responsibility of an annoying decision. It is better that the patient should think that the doctor is the author of the disagreeable necessary discipline and the strict enforcer of the letter of the law, than the nurse, whom she should learn to regard as her best friend.

The nurse should make it a rule to follow the physician out of the room for a discussion of orders, symptoms, and questions of management. Neither these nor therapeutic matters should ever be talked over before the patient. If this going out is a matter of daily routine, the

patient will not be suspicious of it, whereas if it be done but once in a great while she will be sure to fancy that it means complaint or tale-bearing or the gossip of the sick-room. On the other hand, it is well to talk with the patient freely about the nurse, and to consider her opinion, for, after all, she is the person most interested, and to have a daily talk with her without the restraining presence of the nurse. If the case does not do well, and it is not possible to find a clear reason for it, if the food seems to be well assimilated, the functions to be properly performed, and yet the patient does not advance, the attendant should be changed. There should be no hesitation in removing the nurse if she and the patient do not seem to get along well together. Even the best nurses will not agree with every patient, and the writer has recently had occasion to provide three nurses in as many weeks for one lady, although at the same time he was not able to find fault with any of the nurses. Still, we are too apt always to fancy that these difficulties are the patient's fault; often enough they are really the nurse's, for it is a necessary part of the nurse's business to be able to get along well with nagging or fretting patients.

Some other minor qualities must be looked for also in the nurse with whom a patient is to be in close confinement for two or three months. She should be able to read aloud well, and to write a good letter, and she must have intelligence enough to perceive how to interest her patient in little things as she grows better, and to keep her sufficiently occupied to lessen the monotony of the sick-room.

As to the difficulties which follow isolation, they are fewer than at first seem likely. Occasionally patients when first separated from their usual surroundings have an access of emotional symptoms or crises which may last for several days. Only time is needed to relieve this. As to the duration of the isolation, it is hard to make a rule. In milder cases six or eight weeks of it will be enough to produce the effect desired, and the patient may afterward gradually return to her ordinary avocations in society; but the more grave hysterical cases it is sometimes necessary to keep isolated for many months, and inveterate hysterical performers will relapse when seemingly well if the cure is not well established and, as it were, clinched by a careful and methodical life without excitement for months after the cessation of active treatment. The medical attendant must be the judge of how long this seclusion should last. Toward the end letters are allowed to be received limited in number, and later permission is given to write briefly once or twice weekly to her family. Isolation is not a matter of weeks and months, but of results. The results which we desire to obtain are to separate the patient from the habits of long illness, from the too tender solicitude of her family or friends, to restore the en-

feebled will-power and strengthen the morale, and make the invalid once more able to bear her part in every-day life.

Rest.—The second point of the method is rest. This too, like the isolation, is often badly borne during the first few days, but it is astonishing after a time to see how an active and stirring woman will settle down to a life of absolute immobility, and find it not only not disagreeable, but much to her taste.

Rest in these cases is a relative term, and varies from merely lying down for a few hours during the day to entire inaction in bed, carried even to the extent of forbidding the patient to feed herself or to turn herself over. Such strict measures are only necessary in those grave cases in which there is great exhaustion alike of the cerebral and spinal centres. In them no more than the necessary interchange of speech should be permitted. At first, in very serious cases, food is taken better and in larger quantities if the nurse feed the patient than if the patient use her own hands to serve herself. It is, however, seldom necessary to carry the prescription of rest to so extreme a point as this. Ordinarily, the patient is allowed to feed herself while lying upon her back, being only allowed to sit up for the carrying out of her natural functions. In this way no demands are made upon the overstrained nervous centres. The voluntary muscles are not used, the mind is kept as inactive as possible, and the circulation is lowered, to the great easing of the nervous palpitation from which so many cases suffer.

The disadvantages of rest are that it lessens the appetite, that it increases the constipation, which nearly always exists in hysterical and neurasthenic people, and lowers the power of assimilation. These inconveniences we endeavor to remedy by passive exercise, as will be described later on.

When decided improvement begins to be visible in a patient's general state the rest becomes less absolute. A beginning is made by allowing the patient to sit up in bed at meal-time; then for ten minutes twice a day in a chair while her bed is being put in order. This is usually not permitted before the middle of the second month: probably four weeks is the *least* period of rest which is likely to produce favorable results. This sitting up is gradually increased by periods of five or ten minutes daily until the patient is sitting up about an hour twice a day. She then begins to take a few steps, and in favorable cases the exercise is rapidly increased, until at the end of perhaps ten days from her first efforts at walking she is sent for a drive, walking being at the same time kept up and daily increased until a reasonable amount of active exercise is taken. The patient is not permitted to make the unnecessary exertion of going up and down stairs at first, but is carried in a chair to and from her room and her

carriage. Often at this point a difficulty is encountered in those confirmed hysterics who prefer a life of easy invalidism to the burdens which physical well-being and activity impose upon them. They complain that in spite of increased flesh and apparent increase of muscular ability exertion causes pain in the spine, headache, indigestion, and fatigue. But if it is certain that they are well nourished, they should be remorselessly driven by the nurse and the doctor to taking the prescribed daily exercise, and told that the more they disregard the symptoms which result from exertion the less trouble they will give. If they have that necessary faith of which we have previously spoken, they will soon learn the truth of this. Perhaps this is cure by suggestion, but if it be a cure, what matters the name?

For many months, even after an apparent return to perfect health, it is well to direct a certain amount of daily repose, for an hour after each meal, with no occupation, neither talking nor reading, during this time.

Diet.—Next comes the question of food. The patient before beginning her rest should be weighed, that there may be some absolute criterion of the gain made. Dr. S. Weir Mitchell does not, so constantly as he formerly did, begin with an absolute milk diet, finding that many patients do well on a modified diet *plus* milk. But when digestion is impaired or there is gastro-intestinal atony like the asthenia which affects the nerves and muscles, when entire loss of appetite is present, or that hysterical anorexia to which all foods are loathsome, and the patient is in a fair way to become a starving phenomenon, milk diet is the best starting-point. Every day one sees patients struck with horror at the idea of being fed on milk alone or milk at all. They say that milk from their earliest days has disagreed with them; that it upsets the stomach; that it constipates the bowels; that it causes endless strange difficulties. In spite of these assertions, it is rare to find a person who cannot really take milk when it is insisted upon. Sometimes it is necessary to begin with what seem absurdly small amounts—a tablespoonful of skimmed milk four or five times a day, increasing the dose, and gradually increasing the amount of milk while decreasing the other food. Four or five days of milk to start with, even in those cases in which no long continuance of this diet is intended, clears the way for other dietetic or therapeutic measures. In any case only skimmed milk should be used, and it should be fresh and in good order. If no difficulty in taking milk is experienced a quantity of about four ounces may be given every two hours, warm or cold as suits the patient, increasing to eight or ten ounces every two hours. In those to whom the taste after a time grows unpleasant caramel may be added, or chocolate, or a spoonful of coffee or tea, as a flavoring. Some persons do better with barley-water or rice-water added to the milk, and some with

lime-water, but in much the largest proportion of persons carefully skimmed milk without any addition is sufficient. In the occasional cases which cannot take milk in any other form it may be given *partially* peptonized with Fairchild's extract of pancreas; and if this is carried to a very limited degree or the peptonizing agent is only added to the milk as it is handed to the patient, the disagreeable bitterness which results from completely peptonizing is avoided; or koumyss may be given, or Nestlé's Food substituted for a portion of the milk, or used alone if the prejudice against milk is inexorable. Milk frothed with Vichy or ordinary carbonated water is sometimes liked and easily taken. A cup of black coffee in the morning when awaking is sometimes well borne, and frequently without further medicine will keep the bowels in order.

Dr. Kleen contends that milk, though it serves well for children, is not a complete or ideal food for adults, but this is a contention it is difficult to support. It is a complete food if given in sufficient quantity. One case has come under the writer's observation in which a gentleman with advanced diabetes and beginning nephritis lived in comparative comfort, carried on large business interests, and led an active existence for seven years on milk alone. The ease with which it is measured as a food is a great advantage. It lessens irritation in all organs; it makes the patient sleepy; even alone it seems a competent means of fighting hysteria. In nephritis and in diabetes nothing has been found to equal this diet; in stone in the bladder the frequent urination is relieved by a milk diet, and so marked is the result that Paget has suggested that before lithotomy the patient should be fed for some days on milk alone.

If the treatment is not begun with an absolute milk-diet, little need be done in the way of special feeding except to order a digestible and nourishing *menu* until two or three days have elapsed, when, with massage and quiet, both appetite and digestion should have improved, and the patient will very likely be glad to begin the taking of some food between meals, which may be steadily and quite rapidly increased, until the "full feeding" consists of a matter of two quarts of milk a day, besides the regular meals.

If the milk is used at first, after four or five days the patient receives a single chop at mid-day; the next day a piece of toast or bread-and-butter at supper. These two meals are increased slowly for a day or two, then breakfast is added, and when by small advances the patient has arrived at taking three full meals and two quarts or thereabouts of milk a day, it may be advisable to substitute for a portion of the milk some other food, such as Nestlé's or one of the several peptone prepa-

rations,[1] or some of the peptonized foods, the recipes for which are to be found in the books published by the makers of the peptonizing powders.[2]

Massage.—Massage is a matter about which much mystery is made and a good deal of nonsense talked. Some people regard it as a mysterious or miraculous process, like the "laying-on of hands" of the "natural healer," which produces great results in some strange way that we cannot comprehend.

Many different systems are in use, but the really essential parts of the ordinary practice of general massage may be written down in a couple of pages, though of course it cannot be *taught* in that space, for much practice, with careful watching of the progress of the pupil, is necessary to a reasonable perfection in the art. But, given to begin with a certain natural aptitude in the use of the hands, any ordinarily intelligent person who is strong enough can learn it.

For the less severe cases sometimes the nurse may be the rubber, but in the more seriously ill the nurse is so much occupied with other things that to ask her to rub the patient becomes a somewhat severe tax physically. If the physician have no previous knowledge of the qualifications of the masseuse, it is well to see the first treatment or two, lest it should be wrongly done. The ordinary professional rubber has a number of fixed ideas of her own from which it is difficult to wean her, nor does she usually care to learn afresh, in order to meet the views of the physician, a business in which she considers herself quite perfect.[3]

Systematic massage should begin within the first forty-eight hours after the patient is put to bed, and be continued daily for a length of time which will vary with the progress and requirements of the case. It should begin with gentle stroking of the whole body for from fifteen to twenty minutes, for two or three days, then going on to thorough deep massage of the entire surface of the body and limbs, exclusive of the head and neck, and be rapidly increased in duration to an hour or an hour and a half daily. It is rare to find patients who do not, after the first few treatments, bear it well. Now and then one is seen in whom rub-

[1] Most of the "peptones," "peptonoids," "beef-peptones," and so on, as commercially offered, are either of an extremely disagreeable odor or a very sweet taste which is obnoxious to sensitive palates. This latter trouble arises from their preservation by glycerin, which is often in such excess as to act as a purgative. There are, however, two or three excellent preparations, and especial mention may be made of the French "wines of peptone," which have given very good results as tonics and nutriments in the writer's hands.

[2] For dietetic tables see Dr. Yeo's article, p. 691.

[3] For extended information upon the movements and technical processes of massage the reader is referred to the article on "Massage" in this volume by Dr. Benjamin Lee or to Dr. Kleen's book, already mentioned (*Handbuch der Massage*), which is far the best upon the subject that has come under the writer's notice.

bing is followed by a chill or by exhaustion so extreme as to forbid its repetition. Dr. Playfair has found it useful in many cases to order its administration twice daily; and this may sometimes serve, but care must be taken not to over-exercise the muscles of the patient in this way. Dr. Playfair gives one excellent practical hint. He says that he does not care to see that the massage is being effectually carried out. If after a week's rubbing the patient is not taking easily the amount of food prescribed and perfectly assimilating it, the massage is undoubtedly being badly done. The muscle-waste is not being produced which will admit of so much food being absorbed. The proper test is the patient's power of consuming and digesting food.

Another point may be mentioned: that if weighing shows the patient's weight to be increasing with abnormal rapidity, either the massage is not sufficiently thorough or the diet needs regulating in a different way.

Attention should be paid here and throughout the whole course of the case to the urine, as the appearance in it of a deposit of urates is an indication that assimilation is not perfect, and that the patient is taking an amount of food which it is not possible for the system to utilize.

One of the most important parts of the application is the thorough rubbing of the abdomen. This is especially desirable in view of the frequency of obstinate constipation, both in hysterical cases and in persons long in bed. For this the patient should lie upon the back with the head and shoulders somewhat raised and with the thighs slightly bent, and be told to breathe freely and not to make tense the muscles of the abdomen. This last is an order which will be found difficult to obey at first, but which soon is readily followed. The rubber, using either the heel of the hand or the three middle fingers together, begins with a firm, deep pressure, one hand following the other with a slight circular movement, and with sufficient pressure upon the skin to prevent its slipping from under the fingers. This motion is begun in the right iliac region, working gradually upward into the gastric and hypochondriac regions, across at the margin of the ribs, and downward again to the symphysis pubis. In this way every square inch of the ascending, transverse, and descending colon is gone over, except those parts which it is anatomically impossible to reach, the right and left flexures.

For action especially upon the stomach the gastric and left hypochondriac regions should be treated in the same way. Of course only a small portion of the normal stomach can be reached, but should the stomach be in a condition of dilatation a good deal of its surface is brought under the touch.

Many of the foreign manipulators use vaseline or cocoanut oil while

operating. The consequent lessening of friction lessens the stimulation of the skin and makes more difficult the proper deep kneading, besides having other inconveniences, such as its uncleanliness and its amazing promotion of the growth of hair. It is occasionally needed when rubbing hairy men, to allow the hands to slip over the hairs without pulling them.

The observation of trained rubbers about the condition of the patient's muscles is very useful, and one learns to depend a good deal upon what they say.

Electricity.—Besides massage for exercise, it is desirable, when possible, although the least necessary part of the treatment, to use a slowly interrupted faradic current to the muscles once a day, going all over the body—an operation which is easily and rapidly done if the operator knows Ziemssen's points. It is best that this should be given by a physician, but, as it consumes much time, the expense to the patient is increased, and for ordinary purposes it may be sufficiently well carried out by a nurse or a masseur. The slowly interrupted current produces a slight contraction of each muscle, and is, besides, in some way not fully understood, of distinct tonic value. After the daily faradization of the muscles has been completed in cases in which the spinal centres seem affected, the use of the rapidly interrupted current through the spinal cord does good, placing one pole on the nape of the neck and a large electrode upon the soles of both feet, or the ordinary electrode first upon one foot and then upon the other, for a few minutes each. This application should last not less than a quarter of an hour. With these two means, electricity and the kneading of the muscles, we get excessive waste of tissue. We supply this again by excessive feeding, which is made possible by the improved assimilation resulting from the promotion of the digestion and of the circulation brought about by the rubbing and the electricity.

As a trifling practical hint concerning the administration of electricity it may be added that, as many patients fear the very name—some from ignorance, some from recollection of the pain inflicted by its use in rough or incompetent hands—it has become a rule with the writer to begin by passing the electrodes over the skin without making any connection of the wires with the battery. Hysterical patients, already fearful of the results of the application, complain of this excessively. They say that they feel it in their spines or in the tops of their heads, or that they cannot sleep afterward for the excitement which it causes; but if it be kept up for a day or two without regard to the complaints, and they do not then become reconciled, they are then told pleasantly (but without making a jest of it at all) that the complaining has been of the effect produced by two moist sponges, and that no current has

touched them. In fact, the current which need be used in most cases is very mild and should not produce any pain.

The enormous amount of food which can be taken by a patient properly rubbed and exercised in this way is shown in the astonishing reports in Dr. Mitchell's and Dr. Playfair's books. Five pints of milk and a pint of soup or other fluid with three full meals is not an uncommon dietary.

It has already been said that the secretion of urine must be especially watched, so that no deposit of urates may escape notice. It rarely happens that nausea is experienced during the taking of this excessive quantity of food, but if it should be, or should any symptoms of dyspepsia appear, a return to strict milk diet for a day or two will usually be sufficient to settle the rebellious stomach.

Medicines.—The subject of therapeutics, or rather the administration of medicines, may now be considered. If the patient show any degree of anæmia, iron should be given early and continued throughout the whole period of treatment. Malt extract may be used as an assistant to digestion and a useful appetizer. There are now so many good extracts that it is hardly necessary to particularize any one. The maximum amount to be given is about three ounces at each meal, taken before or with the food. A cheaper substitute is three ounces of good brown stout with a teaspoonful of dry malt added.

For the many patients who have an idea that they cannot take iron, one of the nearly tasteless salts, like the pyrophosphate or the lactate, can be dissolved in the malt, and very large doses taken in this way—five to twenty grains three times a day.

Blaud's pill is generally well borne, though perhaps a little constipating, but not more so than other forms of iron; and as much as twenty-five or thirty grains of this preparation may be given in a day, watching the passages to see that none of the pills come away undissolved, which will not happen if they be fresh and well made.

If the case be under treatment in the winter-time, cod-liver oil, in doses of half an ounce or less, may be given half an hour or three quarters of an hour after each meal. Dr. S. Weir Mitchell suggests that in those patients in whom it causes nausea it may be used by enema, and will thus have the double advantage of causing the bowels to act regularly and of being absorbed as nutriment. After the patient begins to sit up and move about, some one of the combinations of iron, quinine, and strychnine, or iron, quinine, and arsenic, may be used. Occasionally nervous patients are made more nervous, or even (though rarely) sleepless, by the stimulating effect of the strychnine, and this should not be forgotten in observing them when they are taking doses of this drug.

An excellent tonic, sometimes better borne than the syrupy elixir, is a

solution of the hypophosphites of iron, quinine, strychnine, and calcium. The ordinary commercial preparations of hypophosphites usually contain an excessive quantity of phosphates, or are either very sweet syrups or solutions of a decidedly acid reaction. Both are objectionable if taken for a long time. A nearly neutral solution is perfectly possible, and any good apothecary should be able with care to make it.

Special Difficulties.—It may be well to speak separately of some of the difficulties which we encounter in the course of treatment, and of the symptoms which call for special notice. At first, in these cases sleeplessness is not uncommon, and there is no objection to an attempt which is very frequently successful to establish a habit of sleep by the use of hypnotics for a few days, should the milk-diet fail to have a sufficient somnifacient effect. Many nervous patients are extraordinarily rebellious to hypnotics, and some have established a tolerance of large quantities by prolonged use, so that experiments must be made with various drugs in varying amounts. Sulfonal or trional, though both uncertain, will often answer well, but must be taken an hour or two before the patient is expected to sleep. The most satisfactory way of giving them is either in small repeated doses of five or six grains each every half hour for two hours before the sleeping-time, or in the maximum dose of from fifteen to thirty grains dissolved in boiling water and taken as hot as the patient can swallow it. The bitter taste is objectionable, but the effect is very prompt. Paraldehyde is occasionally serviceable, but is difficult to take, and the taste and odor remain with the patient for many hours. The newest addition to the list of somnifacients, chloretone, is likewise uncertain, but may do to make a change, as may chloralamid. Sometimes a dose of bromide after supper will take off the edge of a patient's restlessness or nervousness, and may readily be given in the malt if that tonic is used.

Most neurasthenic patients have had insomnia as a symptom, and have been through the list of sleep-making drugs, but it is rare for sleeplessness to continue as a troublesome symptom beyond the first few days, so calming is the effect of the regulated life and quiet of the sick-room. Should they sleep restlessly or wake at frequent intervals, a drip sheet may be used at night in the manner recommended by Ziemssen. The patient, stripped naked, stands in a shallow tub of water at about 100° F., and is wrapped in a sheet wrung out of water at a temperature of about 90°, then rapidly rolled in a warm, dry blanket, and left lying upon the bed for a few minutes. Ten or twelve minutes is usually sufficient to recover from the first shock of the cold water and to experience an agreeable reaction. The patient should then be thoroughly dried by lively friction with a warm

towel, and put into bed wrapped again in a blanket. As the patient improves in strength or becomes accustomed to this application, the temperature of the water may be gradually lowered, but it should never be excessively cold. The action of this measure is not only without danger, but is to most patients agreeable and both tonic and sedative—useful in toning the nervous system and lowering the excitability of the peripheral nerves. This is generally enough to produce sound and refreshing sleep. If it is not, a light surface rubbing with the hand (not kneading the muscles) may be given by the nurse the last thing before bed-time.

Some patients find the employment of faradic electricity to the spine late at night an aid to sleeping, although quite as many think the application of the rapidly interrupted current so exciting as to make them sleepless if it is given in the evening. Some means must be taken to produce sleep if after the first day or two it does not come of itself, for frequently patients will not gain much until you secure a few good nights' rest for them either with a hypnotic or some of the other means described.

In patients with the lesser degrees of neurasthenic or hysteric disorder, who are able to be about, some hydropathic measures are useful; but in those for whom rest-treatment is indicated the necessity for going to a special room for douches and so on is a great objection. Tender spines, local pains, and some neuralgias may derive benefit from water-treatment in bed, if the nurse can be trusted to apply it. For the hysterical tender spine persistent alternating cold and hot sponging is very useful, and is sometimes well borne even when douches and sprays are found irritating or painful. The waters must be very cold, 50° F. or less, and very hot, 102°–110° F., and the alternations rapid. Hot fomentations of a temperature much higher will also in suitable instances be of use for painful and tender spots.

Constipation is an almost invariable accompaniment of rest in bed, and a trouble which one always finds it hard to combat in patients not actively exercising. Should it be obstinate, and not readily overcome by massage of the abdomen or by the fruit which is made a part of the regular diet, a pill of aloes and ox-gall with belladonna, repeated two or three times a day if needed, may be given, or from ten to twenty drops of the fluid extract of cascara sagrada added to the malt extract, once, twice, or three times daily. The extract is more generally effective than the more elegant preparations of cascara, and is not only palliative, but curative, as is shown by the possibility of using it in gradually lessening doses. The rapidly interrupted faradic current used upon the abdomen, with the poles upon both flanks and gradually moved over the surface, but kept well apart, so that the current may penetrate more deeply, is also serviceable.

For very obstinate cases other methods of stimulating and exercising the abdominal organs are needed in addition to the massage of the abdomen in the manner which has been previously detailed. For instance, let the patient lean forward over the padded back of a chair, resting the hands upon the arms of the chair and the lower part of the chest upon its back. The manipulator, standing behind, clasps the belly with both hands and shakes it rapidly up and down and sideways. This reaches all organs, and has the beneficial effect of horse-exercise, but is more severe. The position absolutely relaxes even the most hysterically contracted abdominal muscles. Of course this mode of procedure is not possible until the patient is strong enough to be up and about.

After years of enemata have ruined the muscular tone of the rectum, or in persistent forms of hysterical constipation, electricity, locally applied, is useful. An electrode with an insulated stem carrying a metal cylinder on the end about one and three-quarter inches long and one-third of an inch thick, is inserted into the rectum and an ordinary large flat electrode placed over the abdomen, while a rapidly interrupted faradic current is passed between them for fifteen to twenty minutes daily. The current should be mild, and it should always be tested before applying it. The electrode is moved slowly about, so as to reach all parts of the wall of the rectum, and may be inserted even eight or ten inches. A nurse can do this with a little instruction.

As a preparation for sitting up, Swedish movements are of use, and afterward are of value in order to keep up the necessary amount of exercise; at first they are passive and then active, and, after the patient is moving about, the movements may be resisted. Especially valuable are the resisted rolling in and out and up and down motions of the thigh with the patient seated. These have a great effect upon the pelvic muscles. Various stretching and lifting movements, in which the abdominal muscles are strongly used, help in combating the defective development of muscles weakened by years of corset-confinement, and may be prescribed for patients in whom constipation continues troublesome. (For detailed accounts of these movements the article of Dr. Lee must be consulted.)

A point where a physician new to the management of patients undergoing the rest-treatment will encounter difficulty is when the patient is first called upon to rise from the bed on which she has been recumbent for many weeks. She has been gaining flesh, she has grown rosy, lost the tenderness of her spine or ovaries, her pains, her sleeplessness, and her general nervousness. She is sure to think that she ought to be able to rise directly from the couch and return to her ordinary avocations, unless, indeed, she is one of the inveterate hysterical cases which require to be driven, as it were, at the point of the bayonet to exercise and

movement. It is here that the patient's faith in her physician must be absolute, for when she gets up she will find herself scarcely able to take a step, and too often the mistake is made of allowing or urging the convalescent to do too much or to increase too rapidly the duration of her time out of bed. Every one knows how weak a man feels who has been bedfast, even without acute illness, for days or weeks. It is enough for a beginning to allow the patient to sit up in bed for a few minutes twice daily; then in an arm-chair for ten or fifteen minutes in the middle of the morning (of course without an elaborate toilet), and then for the same space of time in the evening while the bed is being made for her final retirement. These two periods may be increased by daily amounts of five minutes each. When she begins to sit up for half an hour twice daily, the electricity is dropped to three times a week, and active Swedish movements substituted for the passive ones which have been already ordered after the massage. When she has done this for a few days and finds the gymnastics not too fatiguing (and this again is a point to be very carefully watched), resisted movements may be begun and gradually substituted entirely for the massage. After ten days of sitting up the electricity may be stopped altogether. Some rubbing, often only superficial, is agreeable and restful to the patient for several weeks longer. The milk between meals also must be diminished, but need not be stopped entirely, and when the patient has returned to her home she is usually told to continue taking between meals five or six glasses of milk daily.

Active Exercise.—Attempts at walking should not begin until the patient is accustomed to sit up for three-quarters of an hour, and it is not until she can walk freely and steadily about the room that she should leave it. If the need of fresh air be felt, let her sit by the open window carefully covered, and, as her strength increases, begin to practise stair-climbing, commencing with two or three steps down and back, and increasing one step every day; or, should she gain strength fast, a little more exercise may be had. She may now go to drive, and presently to walk. Here, again, is a point at which there is often trouble. Many patients have before partly recovered under various plans of treatment, only to find that when they attempted exercise they again relapsed, and they are constantly filled with fear of active exertion. If the patient is really strong, if her food is well taken and absorbed, her adviser should be discreetly merciless. Not uncommonly a chief reason for disliking walking in the street is the presence of a terror of crowds, a common nervous symptom in some cases.

When the convalescent is able to walk a reasonable distance of four or five blocks, and to take a long drive without fatigue, she should go to the seaside or to the country for a change, to stay three weeks or a month, and thus to test herself and her newly-regained self-control

away from the encouraging presence and moral support of the physician. After this, should it be possible, she may go inland or to the mountains, and thus get the benefit of all that different airs and altitudes can do for her. Each move brings a change of diet, of life, and of surroundings, and after a couple of months spent in this way she should be able to return to her home, and, with common sense as to daily diet, to remain well. Even then a useful precaution to take is to continue a certain amount of rest, especially an uninterrupted hour of entire peace after each meal.

Before her final departure assurance should be had by a careful examination of the eyes that any error of refraction is fully corrected, while any uterine displacement which remains should be mechanically treated.

Duration of Treatment.—As to the total duration of a course of rest-treatment, a definite limit is hard to fix, but a promise should be formally required from the patient or her friends that they will make a trial of at least a month, and in any except the lightest cases it is well on the physician's part to make no promises to let the patient go in less than three months. Of course success may be attained in a very much shorter space of time, and with the fortunate cases which do well from the beginning, where the good-will of the patient is enlisted on the doctor's side and her help aids his efforts, six weeks is a medium period. It should scarcely be attempted in less if any lasting good results are to be obtained—four weeks' absolute rest as described, a week to get up, a week to get out—and even this is hurrying matters a little. Moreover, if the moral effect of treatment and discipline is to be kept up, some hold upon the patient must be retained by regular reports and correspondence, and, if possible, occasional visits until the nervous and physical equilibrium is completely re-established, a matter often of some months.

An example is appended of the form of schedule which the nurse is given when the patient is to be put upon full "Rest-Treatment:"

Miss A. B——.
Oct. 1st, 1890. Last menses, May, 1889.
Nurse C. D——. Weight, 111½.
Masseuse, E. F——.
Bed 3.

Cocoa at 7 A. M.
Cool sponge bath with rough rub, and toilet for the day.
Breakfast at 8 A. M., with milk.
Rest an hour after.
8 oz. peptonized milk at 10 A. M.
Massage at 11 A. M.
8 oz. milk or soup at 12 M.
Reading aloud by nurse half hour.
Dinner at 1.30 P. M.
Rest an hour.

8 oz. peptonized milk at 3.30.
Electricity at 4 P. M.
Supper at 6.30, with milk.
Rest an hour.
Reading aloud by nurse half an hour, 8 P. M.
Light rubbing by nurse, with drip sheet, at 9 P. M.
3 oz. malt extract with meals; tonic after meals.
8 oz. peptonized milk with biscuit at bed-time, and a glass of milk during the night if desired.
Laxative (cascara), 10–30 drops p. r. n.
Later, Swedish movements are added after the massage.

Melancholia.—Melancholia was spoken of in discussing the indications, as contraindicating the full treatment by rest, and before concluding it may be desirable to speak fully of the sort of treatment to be used for men or women the subjects of the minor degrees of this disorder whom it is not advisable to put upon a regimen of absolute rest. The treatment to be described does not require the entire services of a nurse, although in melancholia cases it will be well, when possible, for the patient to be under the care and direction of an attendant. For these persons even more than ordinary care should be exercised in the selection of the nurse, for upon her tact and the strenuousness with which she carries out the minutest details, and the discretion which she must be allowed to exercise as to holding close to or varying from the prescribed routine, much will depend. The course may be called a partial or relative rest-treatment. In this, as in all cases, it is a good rule to put all orders into writing, and the following is the sort of schedule which the patient would receive:

To breakfast in bed, having first taken or, where an attendant is employed, been given a cool sponge bath while lying down. To lie still for an hour after breakfast, neither reading nor writing. To rise and dress slowly. To go for a short walk or to drive or to do some easy and necessary thing for an hour, like a visit, if he be able. He returns to be rubbed, and must rest after the massage for half an hour or an hour. Before and after the rubbing to take a little extra nourishment—soup or bouillon, a glass of milk, or a glass of koumyss. Then comes dinner, and rest in the same way after it. And rest, as I have said before, means lying still, neither reading, writing, talking, nor being in any way disturbed. In the afternoon he has a couple of hours to do as he pleases. The nurse comes in again, and gives, or the patient performs for himself, some active Swedish movements or light gymnastics. After supper he lies down for an hour, and in the evening is left to his own discretion, with instructions that he must be in bed at a moderately early and regular hour. If sleeplessness be a part of the trouble, he starts to go to bed a little earlier, and the nurse makes

another visit for the purpose of giving a light rubbing or the drip sheet, or that combination of both already described.

These cases frequently do well with such a routine continued for many weeks. Some men who have been broken down are able in this way to give a fair portion of their time to business without being absolutely cut off from the activities of life for the purpose of treatment.

In more severe cases the intelligent service of a clever and experienced nurse will be needed, and a schedule must be laid out to cover minutely every moment of the day, in order to leave no unoccupied time for brooding and the cultivation of morbid fancies. In it may be included not only physical treatment as above suggested, but games, reading aloud, small handicraft work, and active exercise in any desired form.

ELECTRO-THERAPEUTICS.

By A. D. ROCKWELL, A. M., M. D.

The General Therapeutical Action of Electricity.

The use of electricity in medicine has become so thoroughly popularized that it is the exception to find a practitioner without some form of electrical appliance, and yet there seems to be in general a very indefinite appreciation of the effects of the passage of the current through living tissue, upon which are based the rationale of every electro-therapeutical result.

To understand its physical and physiological laws is to appreciate the fact that it is a many-edged weapon.

Is it a stimulant? Undoubtedly it is a stimulant of the most powerful character, and an ugly irritant as well when this side of its nature is sought after. Is it a sedative? As a sedative it is in some cases unequalled, and can generally be relied upon to soothe in greater or less degree a functional hyperæsthetic condition of the nervous system. Whether the word "tonic" should be dismissed from the vocabulary of medicine, as some have asserted, calls, it seems to me, for very little serious discussion. The derivation of the term from the Greek τείνω, "I stretch," and from still another word, τονθω, "I brace or give vigor," is sufficiently suggestive. We speak of toning a violin, so that its strings give forth a clearer and better sound. We do this by making them more tense. By this figurative allusion our treatises on materia medica and therapeutics describe tonic medicines as those which gradually produce the requisite degree of tension of the nervous system and of the living fibre generally, and which enable it fitly to respond to all of its natural and appropriate stimuli. "The idea of tension is inseparably connected with all our notions of vital force, because the most common, if not the only, conception we possess of organic power is derived from our experience of the phenomena of muscular force, which is always displayed in connection with the tension of muscular fibre."

Admitting, then, the recognized significance of the word "tonic," and that remedies for improving the tone of the system still hold an important position in the classification of the materia medica, in my judgment electricity must be classed as a tonic of a very high

order. It possesses varied influences of this kind, according to the kind of current used and the method of its application. To produce that tension of the nervous system and of the muscular fibre generally, so as to enable them to respond to their natural stimuli, the mechanical effects of the faradic current seem especially adapted. It is a current of alternation, of to-and-fro motion, of constant closing and breaking. Unlike the galvanic current, it possesses no chemical action to be feared, and no powerful reflex effects need render us unduly cautious in its use. In the passage through the body of a current interrupted with the requisite degree of rapidity it need produce no appreciable muscular contractions, but yet it gives passive exercise to all the deeper-lying as well as superficial tissues. The numerous branch currents going to and fro act as so many shuttlecocks, keeping every atom in incessant disturbance.

Aside from these purely mechanical effects, the experience of every electro-therapeutist must teach him that even the induced or faradic current, and especially currents of high potential and high frequency, as obtained from the Ruhmkorff coil and the Holtz influence machine, exert some other and more subtile influence upon the nerves themselves, for by no purely mechanical effect can we account for the numerous phenomena that follow their use in diseased conditions.

While these mechanical effects of electricity are constantly observed after simple local applications, yet he who uses these forms of electricity in local pathological conditions only, and exclusively for its local effects, will fall far short of eliciting its full therapeutic power. It is this appreciation of the broad therapeutic action of electricity, and a knowledge of the details of the general methods of application necessary for its production, that have aided in the success of so many charlatans. They have accomplished results along certain lines far more satisfactory than those of the scientific physician, who has restricted his excursions in electro-therapy to purely localized methods of application.

Electricity, then, after the method of general electrization may be said to be indicated wherever a constitutional tonic influence is called for. This law renders the remedy as valuable to the general practitioner as to the specialist. For the tedious period of convalescence that often follows typhoid and typho-malarial fevers there is no remedy that is comparable to it, and in a large number of conditions of depressed vitality, electricity, in some one of its forms and by some one of its methods of application, will prove of more or less service. It gives passive exercise to the muscles, it promotes and renders more natural the processes of excretion and secretion; in a word, it imparts tone and strength to both nerve and muscle. With these general principles before us we cease to wonder that electricity is used and recom-

mended for such a great variety of diseases, many of them of an apparently opposite character, and we see the injustice of that criticism which condemns electricity because it is claimed to be of service in so many different conditions. When the therapeutic efficiency of electricity is denied, the inevitable conclusion at which those must arrive who have time and again witnessed evidences of its power is, that he who thus fails in his results is deficient in his experience, is not sufficiently persistent, or has somehow failed in the technique of his applications.

Some of the results in electro-therapeutics are due in a measure—although not in great measure, I apprehend—to physical effects. The heat excited in the tissues by the passage of either form of current is undoubtedly small, but, judging from analogy as well as facts, there can be little question but that an appreciable degree of heat is excited. All conductors of electricity become heated more or less according to the degree of their resistance, and as the body offers great resistance a certain proportion of the electric force must be converted into heat. It is, at all events, a demonstrated fact that cold extremities are sensibly warmed by faradization or galvanization, even when but few muscular contractions are produced.

Electricity possesses well-known physical effects on metals. Platinum wires are contracted by the passage of electric currents through them, and copper wires that are freely used for conductors become brittle, and it is said that the copper wires that conduct faradic currents break more speedily and more frequently than those which conduct galvanic currents. These physical facts are very suggestive of what may be facts in physiology and pathology sufficient to account for some of the therapeutic effects of electrization that as yet have hardly emerged from the realm of empiricism. These possible physical and physiological changes apply especially to the after or secondary effects of electrical treatment—effects that are noticed, not while the applications are being made or during the course of the treatment, but weeks and months after the treatment has been discontinued.

The chemical or electrolytic influences that are associated with electrical action are practically confined to the galvanic current. Its visible effects occur when needles or pointed electrodes of metal are used, and its especial utility is in the department of electro-surgery, although it is undoubtedly true that some electrolytic action occurs in all ordinary applications of the galvanic current to the body whatever form of electrode is used, and is probably a factor of more or less efficiency in making up the sum of electro-therapeutical effects.

A distinction has been made, and justly, between electrolysis and galvano-chemical cauterization. The one is a disintegration and separation of the constituent elements of organized structure. The other produces its effects by means of the acids and alkalies that are liberated at

either pole by electrolytic action. It is the chemical galvano-cauterization, and not the electrolysis, that accomplishes most of the good results that follow intra-uterine applications in cases of endometritis, and yet that the beneficial effects are not due solely to the acids and alkalies is evident from the fact that when ordinary acids and alkalies are applied to the body, eschars of the same degree and kind are not obtained. The current penetrates and pervades the tissues, and induces various changes beyond and beneath the eschar which continue long after the current ceases to flow.

In its influence over nutrition, however, the physiological effects of electricity are perhaps the most important. Mechanical, physical, and chemical effects must indeed combine to make up physiological effects. The former are observed on dead as well as living, on inorganic as well as organic, substances; the latter are peculiar to the living body only. Physiological effects are those which take place by virtue of the vital properties of the body, and cease when life ceases. The action of all currents modifies physiological function in various ways.

First. It may increase it. This action of the galvanic current is so well known as hardly to need mention. The readiness with which the secretion of the salivary gland can be increased is readily demonstrated. Mucous secretions are very quickly increased by the action of either current, and the effects of electrization are being utilized more and more in diseases characterized by a suppression of the normal mucous secretions. Especially in the so-called dry catarrh is the treatment efficacious, as has been shown in many cases. The effect of electricity on the biliary secretion, on the gastric juice, and on the intestinal fluid, is probably stimulating, but is less easy of mathematical demonstration. Certainly, these fluids ought to be secreted in greater abundance under the influence of the current, and the results of treatment in pathological cases give this probability something of the force of certainty. My own experience is that the appetite is sharpened, digestion quickened, and constipation relieved both by local and general electrical treatment —so decidedly in many cases as to make it pretty evident that the gastric and intestinal glands are made to secrete more liberally by the action of the current upon the nerves that supply these organs than on the tissues of the organs themselves. These results, that have been familiar to me for years, have recently been confirmed by Ziemssen in a very interesting manner by experiments on animals. He found that either form of current would increase the secretion of the various glands.

The subjective effects of the electric treatment act the same way in the bowel as in the stomach, by invigorating and improving the appetite. In the bowel it diminishes or removes the painful tenderness in the lower part of the body, as well as the feeling of movement or heat

that is frequently experienced. The objective effects of the treatment, Ziemssen conjectures to be, that the stimulation of the motor nerve excites the intestinal ganglia, and thereby increases the flow of secretion from the intestinal glands, as well as induces a flow of the pancreatic and biliary secretion.

Among those affections of the bowels in which electricity is quite certain to exercise a beneficial influence are defective innervation, atrophy of the muscles of the bowels, digestive atony, and that large class of diseases comprehended under the name of hypochondriacal and neurasthenic.

Second. Electricity may not only diminish, but it may arrest, the physiological activity of the organs of secretion and excretion.

When, as in polyuria, the general application of the current is often followed by a marked diminution in the flow of urine, it is a desirable therapeutic effect, but the effect to which I allude is far from desirable. It comes from the use of currents so strong as to paralyze glandular function. On the lacteal secretion it acts with decided though varying power in increasing it, or in restoring it after it has been temporarily suppressed; but in two cases I have known this secretion to be promptly suppressed by the injudicious use of currents of high tension. On the circulation the influence of electricity is a complex study, since it comprehends its action on the heart and on the unstriped muscular fibres of the arteries, as well as upon the central and peripheral nervous system.

Certainly, very sensible modifications of the circulation may be observed in any strong and prolonged application of either current, and generally on the side of an increase of the flow of blood and some elevation of temperature, with dilatation of the veins.

On the absorbents the action of electricity has been found to be of practical value in relieving many hypertrophies, effusions, and morbid growths. To follow out the rationale of its operation in producing these effects would be a difficult and tedious task, and it can only be said here that the effects of electricity on the excretory processes of the body, its direct chemical action, and its influence over the circulation in the arteries, veins, and capillaries by its power to increase the quantity and quality of innervation received by them, must constitute most important factors in influencing the process of absorption.

Not only does electricity directly influence nervous action through the vaso-motor system, but it excites vital function by acting directly on the cell itself and on the protoplasm, thus hastening nutritive changes and cellular activity; excretion is stimulated and poisons are eliminated. In further explanation of the *rationale* of the therapeutic action of electricity, the discovery of M. Edouard Branly,[1] if not

[1] See *L' Actualite Médicale*, Dec. 15, 1897. *Revue Internationale d'Electro-thérapie*, March, April, and May, 1898.

conclusive, is at least most interesting, and may throw light on the pathology and treatment of the functional neuroses. Through no possible interpretation could it have interest for us on the old theory of the anatomical continuity of the nervous system ; but in the light of the discovery of the neuron, by which we find the nerve tissue made up of distinct and disconnected elements, it immediately becomes worthy of consideration. Briefly stated, M. Branly discovered that if a tube of iron-filings be placed in a weak galvanic circuit the meter fails to register, thus showing that the substance is practically non-conducting. If, however, the tube is previously placed in a solenoid through which courses currents of high frequency, or is simply subjected to the influence of static electricity or of the cathodic ray, the tube instantly becomes a conductor and the current passes. Subject the tube with its contents, however, to some sudden shock, as that of a static spark or blow, and its conductibility is immediately annihilated. Various theoretical considerations, unnecessary to discuss here, are advanced in explanation of these phenomena. They may or may not be the true solution of this mysterious happening; but we certainly see a similarity between the individual iron filings of the tube and the individual neurons of the nerve substance, and a striking analogy between them in their relation to electric energy and shock, which may throw light not only on the physiology but on the cause and cure of the functional neuroses. It is well known that we can hasten the recovery of hysterical paralysis by placing the patients in an electro-static field, or subjecting them to the influence of currents of high potential and high frequency by other forms of electric energy. The analogy between the two—the tube of iron filings and the nerve structure—may be carried still further, since the restored nervous conductibility in a case of paralysis of hysterical origin may be instantly annihilated, as is the electric conductibility in the tube of iron filings by sudden shocks. "Does not this help to make clear to us the characteristic causation of hysterical paralysis? Does it not reveal the traumatism which produces them. Moral or physical traumatism, emotional shock or railway accident, psychical influence or injury, brutal application of physical agents, heat, cold, light, etc.—in fact, all violent excitation is capable of producing loss of conductibility of the nerve current proper, in or through the neurons, as it can restore it when abolished." In certain cases of hysterical paralysis, patients who have been confined to bed for months or years have suddenly regained power when some violent neuro-motor excitation, such, for example, as sudden conflagration, has overcome the non-conductibility of the neuron. Whether or no this discovery is sufficient to furnish the key—as its enthusiastic advocates suggest—to

the cause and cure of the functional neuroses, it at least opens up a novel and interesting field of research.

The Dosage of Electricity.

The more thoroughly one studies electro-therapeutics in all its relations, medical and surgical, the clearer it becomes that the real scientific basis for the use of electricity in medicine and surgery is found in electro-physics more than in electro-physiology.

The rationale, therefore, of the various methods of electrization, of galvano-cauterization, and the important department of electrolysis can be satisfactorily understood by those only who have grasped the elementary principles of electro-physics—the laws of resistance and conductibility, and, above all, the law of Ohm. Those who have been once well grounded in these laws of electro-physics find that the various special problems that arise, whether of a theoretical or practical character, very quickly resolve themselves.

I do not propose here, however, to discuss the complicated subject of electro-physics, but to offer a few practical suggestions in regard to the important topic of electric dosage.

In some conditions and with some individuals the difference in result between a very gentle and short application and a very strong and protracted one is nothing more nor less than the difference between agreeable success and painful failure, while in other conditions and with other individuals the difference between success and failure is measured by the difference between strong and short applications and mild and protracted ones.

There are persons who must be treated not only mildly, but at long intervals; and there are persons, with perhaps the same maladies, that can bear with advantage powerful and frequent applications: to distinguish between these classes, and the various gradations that lie between the extremes of tolerance and of susceptibility, is the first duty, and oftentimes the hardest study, of him who makes much use of electricity in medicine. To state in definite terms the solution of the problem of electric dosage as it relates to these various classes and gradations is a task that I by no means propose to undertake. The ability to measure with the utmost nicety the strength of the current does not solve the problem. Such precision may be of the utmost value in the continued treatment of any given case of neuralgia, for example; but the strength there used may in no way answer for the next case, and therefore recorded statements of the number of milliampères used, in different forms of nervous disease especially, are by no means as valuable as one might be led to believe. A clear appreciation of the fact that the human system reacts to no drug with such varying susceptibility as to electricity is one of the first and most

important lessons to be learned. When we come, however, to the department of electro-surgery as represented by electrolytic action, the case is widely different. To produce certain local effects requires a certain definite expenditure of force, and the question of idiosyncrasy cannot be so much considered, although even here it is not to be altogether ignored.

The "dead-beat" milliampèremeter is a great improvement on the old form of galvanometer for measuring the strength of the galvanic current. Many of the meters even now in use register but forty or fifty milliampères, and oscillate so persistently as greatly to inconvenience the operator.

This instrument of precision by means of two short coils will accurately measure as high as five hundred or as low as one-tenth of a milliampère. The dead beat or damping effect is obtained by suspending the needle in a cylindrical block of copper three times the diameter of the needle. The current in the copper, induced by the swinging of the powerfully magnetized needle, causes the number of its oscillations to be reduced to three or four, making it possible to take a reading instantly. In some meters these oscillations amount to thirty or forty. The milliampèremeter has been used in therapeutics but a comparatively short time, although for many years nervous as well as other diseases had been treated by electricity with different degrees of success, according to the individual experience and skill employed in its use. Personally, although acknowledging the great utility of accurately measuring the strength of the current, I cannot claim greater success in the treatment of most nervous diseases, now that the milliampèremeter is employed with every application, than formerly when it was unknown; and this experience is, I fancy, common to all those who have through years of work become practically familiar with the routine of electro-therapeutical treatment.

And yet it is an immense convenience. It relieves the mind of all anxiety in regard to many minor details, and he who has once tested it will never willingly be without it. For the tyro, however, it is, I am sure, a necessity. Without it he will find himself working entirely in the dark, and a beginner should no more think of attempting serious work without his indicator of current-strength than he should administer drugs without his apothecary's measure.

Another appliance convenient to have, but not always essential, is the rheostat, the utility of which I will briefly illustrate. To-day, for example, the observer notices that the current from a given number of cells is painfully felt by the patient, while to-morrow the same strength, applied to the same patient, may be felt but slightly. If no milliampèremeter is used the mystery seems very great, and I know not how many times I have been asked for an explanation. If, however, the current

is measured, the mystery is solved, for it is observed that when pain follows the application a greater number of milliampères is registered than when no pain is produced.

All this is explained by the fact that the skin varies very much on different portions of the body and in different physical conditions as to its conductibility. Now, if on one day, in an application to a patient of a current from thirty cells, the meter registers thirty milliampères, and on the next the same number of cells, with the electrodes applied on the same portions of the body, cause the meter to indicate but twenty, we know that the patient is offering a far greater resistance to the current on the second day than on the first. It is not essential for practical purposes that we know just what that resistance is, but it is desirable and interesting to know, and the rheostat supplies this knowledge with absolute exactness. In order to find out the resistance when the registration is thirty, we substitute a rheostat for the body of the patient, and introduce a number of ohms in the circuit sufficient to hold the needle at thirty. If the number of ohms found necessary is three thousand, then three thousand is exactly the resistance offered by the body of the patient on the first day. To find out the resistance when the meter registers but twenty the same process is repeated, and if the number of ohms registered is five thousand, we know that five thousand ohms is the amount of resistance offered.

The utility of the rheostat in therapeutics is more especially in the direction of enabling us to increase or decrease the current gradually and without shock. After intercalating a resistance of one thousand or more ohms, we bring into action the number of cells that will probably be required. By gradually reducing the resistance in the rheostat the milliampèremeter soon marks the degree of quantity required. To decrease the current the resistance in the rheostat is as gradually increased until the needle points to 0, an indication that the resistance equals the strength of the current. The Germans taught the use of ridiculously weak currents, and, influenced by these teachings and by a natural respect for an agent so subtile, the average degree of strength employed when I began the use of galvanism was in many cases entirely inadequate. In its application to the head ten or twelve cells were, as a rule, considered quite sufficient. Beneficial results were often seen to follow such mild treatment, it is true, and it was seldom that greater strength was attempted; but that the dose of electricity thus obtained was exceedingly slight, and far more inefficient than was then supposed, can be readily demonstrated. The cephalic electrode was a broad, thick sponge, while the other electrode, applied generally to the pit of the stomach, was of sponge also, but much smaller. The resistance thus offered is necessarily very great, and if the milliampèremeter is used, it will be found that the actual quantity of electricity passing through

the body of the patient hardly exceeds six or seven milliampères. Now, to use a current of only this strength in applications to the nerve-centres is, as a rule, little more than child's play.

Sometimes benefit may undoubtedly accrue from these very mild applications, but I have for so long a time observed the effects of a bolder line of treatment that I have no hesitancy in advocating it in preference to former methods. In place of a current of five or six milliampères substitute one of twenty, and the superiority of the results thus obtained will soon become manifest. But if, by the method in common use, twelve ordinary cells in the treatment of the head deflects the needle but about five degrees, it would take some forty-eight cells to give a strength of twenty milliampères; and few physicians have any such number at command.

For this purpose the electrodes should be as large as possible; that is, broad, flat, or curved, according to the part of the body to which they are applied, but with little bulk. With electrodes such as these, and a series of sixteen Leclanché cells, a current of twenty milliampères can readily be obtained in applications from the head to the solar plexus. Thirty-two cells would therefore give forty milliampères, an intensity of current seldom necessary to exceed, or even equal, in central galvanization. In making these strong applications to the brain there is an element of danger which cannot be emphasized too strongly—namely, the possibility, and indeed the probability, considering the utterly haphazard way in which electricity is too frequently used, of the current becoming suddenly broken. Even with very weak currents applied to sensitive nerves or to the head interruptions are, as a rule, undesirable, and when strong, as indicated by a deflection of the needle of fifteen or more, they may painfully aggravate the very symptoms that you are endeavoring to allay. As an illustration of this most important fact, I will refer to two out of a number of cases upon which this statement is based.

The first was a case of epilepsy, one which had been helped up to a certain point only by the persistent use of the bromides, but which had very greatly improved, and finally recovered, when the treatment was supplemented by galvanization of the brain. The attacks had been growing far less frequent, and at this time some three months had elapsed since the last. The patient was feeling exceedingly well, and this in itself was by her regarded as a guarantee of exemption, for invariably before a paroxysm she was accustomed to feel far from well. With one pole at the epigastrium and the other on the head I was gradually increasing the current until it probably indicated some fifteen or twenty milliampères. In some way the connection was suddenly broken, and, with the characteristic cry, the patient fell over in an

epileptic fit, and one, as I afterward learned, of far greater severity than usual.

The other was a severe case of chorea of long standing. The patient was slowly but surely recovering, and had so far regained command of his lower limbs that he could walk with but slight evidences of any lack of co-ordinating power, and could use his knife and fork with ordinary readiness. About this time he inadvertently received a shock through the head of a current-strength of some twenty milliampères. Results of a most unpleasant character followed. The choreic movements of the arms and legs returned in a marked degree, so that he walked with uncertain steps and could no longer feed himself. These aggravated symptoms continued for about ten days, and then began gradually to subside.

I would by no means be understood to say that a galvanic shock, even though severe, will always cause marked increase of symptoms that are subsiding under the use of an uninterrupted stable current. Such shocks are many times given without any apparent evil result. They should, nevertheless, be guarded against in every possible way, as their tendency is undoubtedly harmful.

One of the diseases to which I will refer in giving more definitely my own experience in regard to electric dosage is epilepsy, a condition in which electricity is far from being generally recognized as capable of any special service. As far back as 1878, I wrote upon the subject, and recently gave, before the New York Academy of Medicine, the results of my observations in twenty-eight cases. All of these twenty-eight cases of epilepsy were treated without the aid of accurate current-measurement, since the milliampèremeter is of comparatively recent introduction. It is, however, possible for me to give approximately the strength of current used in most of these cases. The range was between ten and thirty milliampères. I have found no patient suffering from epilepsy who could not endure, without ill effects, a current of ten milliampères, provided the cephalic electrode covered a surface sufficiently large and was accurately adjusted, while most of them bore without discomfort a much stronger current. I should regard more than thirty milliampères seldom if ever desirable. The strength that I have found most generally acceptable and of service to my patients has been from fifteen to twenty-five milliampères.

In chorea substantially the same rule prevails in regard to strength of application, or would prevail if the average age of choreic patients was not much less than that of epileptics. The strength of current applied to the head in any case of chorea under twelve years of age should rarely exceed twenty milliampères, and generally should be about twelve.

We cannot approximate the relative dose of electricity for different

ages as accurately as we can that of drugs. The following observations, however, will be found to be uniformly correct. The very young bear proportionately very much stronger currents than adults. A child of three years, who should, according to rule, tolerate only about one-fifth the adult dose of any powerful drug, will easily bear one-third, and sometimes one-half, the adult dose of electricity. Old people bear stronger currents than those in middle life; it is, indeed, quite astonishing to observe the very marked insusceptibility of some very old people to electricity, due in some measure perhaps to blunted sensibility, as well as to a loss of conductibility of the tissues, and especially of the skin. It will not answer, however, to presume too much in the application of electricity to the old on account of this apparent insusceptibility, as it is not uncommon to meet with persons advanced in years who, while they may feel the application of a certain strength of current but little at the time, are yet exceedingly susceptible to its secondary effects.

Another disease for the relief of which the galvanic current is but indifferently appreciated is exophthalmic goitre. Without it, indeed, it is often impossible to obtain results at all satisfactory, but with it marked amelioration of the symptoms almost invariably follows, and not infrequently complete or approximate recovery in cases that have responded unsatisfactorily to internal methods of treatment alone. The strength of current indicated varies according to the position of the poles. An important point for local application is the auriculo-maxillary fossa, immediately below the lobe of the ear, where but a comparatively small electrode can be used. A strong current would produce both pain and vertigo, and from five to seven milliampères is about all that will be well borne with an electrode in this position. As we gradually move the pole down along the inner border of the sterno-cleido-mastoid muscle the strength can be increased very materially, and with one broad electrode at the back of the neck, near the sixth cervical vertebra, and the other on the enlarged gland, currents of twenty and thirty milliampères can be profitably utilized. The variation of current-strength in the treatment of neuralgia and pain in general is as wide as the symptoms are varied in character and seat, and more perhaps than in other diseases is it necessary to discriminate carefully in the selection of the proper current. True neuralgia (pain directly along and confined alone to the course of a nerve) calls almost invariably for the galvanic current, while the so-called pseudo-neuralgias, which are simply forms of pain occupying certain areas and running seemingly in the direction of certain nerves, yield most readily to faradism. From five to ten milliampères are, as a rule, amply sufficient for the relief of neuralgia about the face and head, while in sciatica, it is often necessary to use as much as forty or fifty, or even more. The efficacy of very strong currents in the treatment of sciatica

should be more generally recognized. As ordinarily used, it often fails to relieve because of an insufficient current. The operator is simply self-deceived. He is using perhaps a large number of cells, freshly and properly charged, but his electrodes are of a pattern and size to offer the greatest possible resistance. Let him substitute electrodes that are broad and flexible, readily adapting their shape to every inequality of surface, and this difficulty of lack of strength will quickly disappear.

In the treatment of paralysis, whether central or peripheral, the dose of electricity is determined by so many modifying factors that it cannot be fully discussed here. The general law, that when a muscle fails to respond to the faradic current recourse must be had to the galvanic, is now usually appreciated, but it is not so generally understood that paralyzed nerves are not to be indiscriminately stimulated by sudden shocks. Many a paralysis that might have recovered has been made permanent by such ill-directed and culpable interference.

After the degree of quantitative or qualitative change has been determined by careful interrogation of the affected muscles, it is in many cases imperative to use the continuous and not the interrupted galvanic current. Especially is this true in those cases of local paralysis in which responses utterly fail to be elicited by the faradic current, but are more readily obtained through the galvanic current than in the normal condition of nerve and muscle. In such cases mild currents of about seven milliampères, increased to twelve or fifteen as improvement increases, and applied without interruption, will succeed in lessening the irritability of muscular fibre and in restoring the lost vitality of the intra-muscular nerves—upon the integrity of which the faradic current depends for its ability to call forth muscular contractions—far more effectually than when interruptions are attempted.

In most forms of paralysis, however, much stronger currents than these can be employed. In infantile paralysis fifteen or twenty milliampères may be used, and in the spinal paralysis of adults (polio-myelitis) twenty-five or thirty are usually indicated. In both these conditions, but more especially in infantile paralysis, the same rule should be observed as in the treatment of the form of facial paralysis to which allusion has been made—for the most part continuous and not interrupted currents.

Given a case of infantile paralysis in which reaction to the faradic current is entirely lost, and only faintly appreciable to the galvanic current, it is entirely possible by sudden shocks to obliterate the little remaining vitality and render the case incurable.

In hemiplegia, again, while electricity possesses but a limited value, it is yet capable of doing decided harm. I have at this time under observation a hemiplegic patient whose arm was in such a condition of heightened irritability that contractions to both currents were called

forth far more readily than in health. He fell into the hands of one who possessed greater activity than insight, and was subjected to a series of treatments by the faradic current in which the muscles of the arm were jerked about in a most merciless manner. As might have been expected, there soon supervened an entire loss of motility, together with neuralgic pains of a distressing character.

In alluding to epilepsy and chorea, I spoke of central galvanization and its dosage in those diseases. Central galvanization is also a valuable method in many neurasthenic conditions, in hysteria, and in cases of melancholia. The hair being thoroughly wet, a light wire gauze helmet, lined with some soft conducting material, is fitted as accurately as possible to the head. To this is attached the positive pole, while the negative is applied to the pit of the stomach and a current passed, varying, according to the disease and individual idiosyncrasies, from five to thirty milliampères. It may seem an easy thing to make use of central galvanization satisfactorily, but, like most easy things, its efficient use demands knowledge, care, and some experience; all of which are within easy reach of those who desire to utilize the method. The wide area which this helmet electrode covers lessens by just so much the resistance to be overcome, and enables us to pass through the head a current of many milliampères without pain or other ill result. To this end, however, the electrode must be made to adjust itself accurately to every inequality of surface, otherwise a painful concentration of current will be felt at various points and the efficacy of the application interfered with.

Any discussion of the subject of electric dosage would be incomplete without reference to gynæcology, in which electricity has accomplished much good. Here, more than in any other department of medicine, is illustrated the great superiority of strong and comparatively short applications, over those which are weak and prolonged.

Much of the ill-success that formerly attended the treatment of diseases of women by electricity was due to the use of too feeble currents, and the same misapprehension as to its actual working power, alluded to when speaking of central galvanization, existed here. With one ordinary small and comparatively thick sponge electrode applied externally to the abdomen, and the other internally, a current from thirty-six cells will cause a registration possibly of not more than twenty-five to thirty milliampères. A current of this strength is entirely insufficient with which to treat successfully many uterine diseases that experience has shown to be amenable to electrical applications; and in order to obtain the requisite strength without resorting to the great number of cells that would ordinarily be required, electrodes of an entirely different pattern are necessary. They should be large and flat, and readily adapted to every inequality of surface.

Apostoli, whose experience has probably been greater than that of any other in the electrical treatment of the uterus and its appendages, first suggested the electrodes made of sculptor's clay, held in place by gauze and sufficiently large to cover much, and sometimes the whole, of the abdomen. The principle involved is simply this: The larger the electrode, the less the resistance, and, other things being equal, an electrode of six square inches will yield but one-half the current of one of twelve square inches. In the treatment of uterine diseases it must be remembered that the internal is the effective pole, while the external is the indifferent or dispersing electrode. Bearing in mind also that the genital mucous membrane is remarkably insusceptible to painful impressions, while the skin is the reverse, the necessity of large flexible electrodes that can be accurately adjusted is readily appreciated.

In the treatment of indurations and enlargements of the uterus and the exudations resulting from pelvic cellulitis direct applications frequently result in complete recovery. Currents of from thirty to fifty milliampères are indicated, and should not cause the slightest pain. On the contrary, there is often instant relief afforded to an ever-present pain, as well as the more remote results as seen in the correction of painful menstruation. If the metal electrode is applied directly, without the intervention of some covering, care must be taken not to use currents sufficiently strong to produce eschars. This mishap may occur even without the knowledge of the patient, and it is therefore always safer to use a covered electrode.

I have seen this treatment, judiciously and persistently carried out, melt away, as it were, not only large pelvic deposits, but in two instances relieve a most severe and chronic sciatica that had been caused by the pressure of these pelvic deposits. In ovarian and fibroid tumors the electrolytic method is undoubtedly worthy of consideration, although in ovarian tumors the results have not as yet been sufficiently satisfactory to commend themselves strongly to authorities in the department of uterine surgery.

It is perfectly safe to use currents of from one to two hundred milliampères in the treatment of uterine fibroids. Whenever in the use of electrolysis our aim is destruction, and only destruction, I see no reason why even stronger currents might not be used. In one case of uterine fibroid at a clinic at the New York Post-Graduate Medical School, I myself used a current-strength of three hundred and fifty milliampères.

It must be remembered, however, that some of the best results of electrolysis are not measured by the degree of chemical action, and that when various external tumors, such as goitre, disappear under feeble electrolytic action, it is through a process of absorption that is set up,

and not because of the destruction of tissue. In the treatment of goitre currents of forty milliampères are indicated. Absorption is hastened by the chemical changes that occur, and takes place both during and after the treatment. In most cases it is not observed at all during the operation, but goes on slowly for weeks following.

Stimulation of absorption is especially marked when electricity acts on hydrocele and small cystic tumors. For their treatment a current of thirty to forty milliampères is required. In erectile tumors, in which the object is to coagulate the blood, we use about the same strength as when treating cystic tumors.

Current Differentiation.

A frequent question, and one somewhat difficult to answer without qualification, is, Which of the two forms of dynamic electricity is the more useful in practice? As generally used, undoubtedly the galvanic current has a wider range of usefulness in medicine and surgery than the faradic. In other words, and generally speaking, diseases and symptoms of disease that are circumscribed and local indicate, as a rule, the galvanic rather than the faradic current. If, however, a broader view of the remedial action of electricity be taken, and its powerful tonic influence recognized when administered by the methods demanded for the production of such effects, it is quite another matter, and the faradic current, together with those kindred manifestations of electricity, the high potential and high frequency currents, assume an importance which any form of local use fails to give.

It may be said, therefore, that if the general practitioner will make himself acquainted with general faradization, and take the time and trouble to apply it with the thoroughness that its successful use demands, he will accomplish quite as much with the faradic as with the galvanic current, although in quite a different class of cases.

In briefly discussing the relative efficiency of the two forms of dynamic electricity in medicine, I will first consider the measure of their agreement and disagreement in their physical and physiological activities, and, second, state some of the differential indications for the use of the currents in treatment. The first of these considerations is necessary to an intelligent appreciation of the second, for the more thoroughly one studies electro-therapeutics in all its relations the clearer it becomes that the real scientific basis for the use of electricity in medicine and surgery is found in its physics and physiology, especially the former.

Now, electricity, however generated, whether through chemical action, through friction, or through induction, and however modified by its passage through any resisting media, is electricity still. Both currents, the faradic and galvanic, are obedient to the law of Ohm, and while

there is a wide difference in the degree of their physical and physiological properties, these are in kind essentially the same.

Both currents are capable of producing electrolytic effects, and this can be readily demonstrated with the current from the first induction coil of an ordinary faradic apparatus. The action of this current on a solution of salt and water is exactly the same in kind as the action of the galvanic current. Both currents also evolve light and heat, and the bright deflagrating spark caused by the electricity as modified by the thick, short coil of wire is even more brilliant and disintegrates metal more readily than the current direct from many cells. Both currents will electro-plate, and by some of the giant magneto-electric apparatus this is done on an enormous scale.

The milliampèremeter is an instrument of precision that is now indispensable in the use of the galvanic current, and yet by connecting the posts with the poles of a faradic apparatus an appreciable deflection of the needle is observed, and this deflection very naturally becomes still more marked if the current from the primary coil is thus utilized. This power of the faradic current to cause, like that of the galvanic, electrolysis and deflection of the needle is so inferior in degree to the power of the galvanic current that we cannot utilize the former in electro-surgery, nor is the galvanometer available to measure its strength. Thus it can be readily demonstrated that, however differently generated or however modified by the medium through which they pass, the various forms of electricity are only different manifestations of one great force.

Physiologically, we find this agreement between the effects of the two currents quite as close as when physically considered. The phenomenon of electrotonos, to be sure, has been demonstrated only as it relates to galvanism, but it is the common experience that even with the faradic current the positive pole is the more calming, and the negative the more stimulating.

Applied directly to the brain or spinal cord, both currents excite muscular contractions, and about in the same degree, similar results having been obtained in the well-known experiments of Fritsch and Hitzig, who used galvanism alone, and of Ferrier, who used faradism. The result of direct electrization of the sympathetic nerve is a change in the calibre of the cerebral blood-vessels, and the only difference in the action of the two currents is the greater rapidity with which effects follow the application of the galvanic current. The nerves of respiration are affected in about equal degree by both currents, and even in their action on the nerves of special sense the close relationship of the two is unmistakably evident.

You cannot in a healthy person—or, as a rule, even in one that is

sick—so excite the optic or gustatory nerve by the faradic current as to call into activity the vital function of these nerves. There are, however, some exceptions to this, as exemplified in certain hysterical and neurasthenic cases in which there exists an unusual susceptibility of the nervous system. In such cases the faradic current has occasioned not only the appearance of flashes before the eyes and a metallic taste, but the auditory nerve itself has been known to respond to its influence. These examples are quite sufficient to show that the action of the two currents is so similar as to prove them substantially the same in kind, but at the same time so widely do they differ in the degree of their physical and physiological power that it is often practically equivalent to a difference in kind, rendering one current inferior or superior to the other in a most remarkable degree, according to the special indications in individual cases.

In view, therefore, of the superiority of the galvanic to the faradic current as relates to its physical and physiological energies, it seems hardly necessary to say that the former is to be used when we wish to act with special electrotonic and electrolytic power on the brain, spinal cord, the sympathetic, or any part of the central or peripheral nervous system. We use it when we wish to produce contractions in paralyzed muscles that refuse to respond to the faradic current, and in electro-surgery when we desire to produce, through electrolysis and cauterization, the destruction or absorption of morbid products and the coagulation of blood. We use the faradic current to act mildly (probably for the most part through reflex action) on the brain, spinal cord, sympathetic, or any part of the central or peripheral nervous system. We use it to excite muscular contractions whenever the muscles are not so much diseased as to be unable to respond to it, and to produce those strong mechanical effects through which, in great measure, are obtained the remarkable constitutional tonic influences now everywhere so well recognized.

In order to illustrate a point in current differentiation which I regard as of considerable value I may be allowed to instance two cases. The point to which I refer relates to the effects of pressure as indicating the kind of electricity most likely to prove of service in the different forms of pain for which relief is sought. Without attempting to discuss the relation of pain to pathological states or its different forms and locations, I call attention to the well-attested fact that of all innoxious remedies electricity is the most powerful agent in nature for the relief of pain. Not that it never fails, for this it does often enough, but its failures would be far less frequent and its reputation along this line more firmly established if the differential indications for its use were more carefully considered.

It is a common observation that in many forms of pain and so-

called neuralgias firm and equal pressure over the affected parts causes no discomfort whatever, and frequently affords marked temporary relief. In other cases the parts are sensitive to all external impressions, and pressure or rubbing decidedly aggravates the existing pain. True neuralgia is undoubtedly, as a rule, represented by the last class of cases, while the former class, in which pressure relieves and in which pain occupies certain areas and runs seemingly in the direction of certain nerves, must be classed among the hysterical and pseudo forms of neuralgia.

In true neuralgia the pain invariably can be definitely mapped out along the line of certain nerve-trunks, and in these cases the galvanic current is almost without exception indicated, and not the faradic. In the hysterical and false forms of neuralgia, however, the indications for the faradic current are almost as invariable as they are for the use of the galvanic in true neuralgia. I say almost, for we do occasionally find cases of the pseudo and hysterical forms of neuralgia in which the affected parts are not only sensitive to pressure, but also unusually sensitive to the effects of electricity, affording additional proof of the general correctness of the statement that painful parts that are sensitive to pressure indicate the galvanic, and those that are insensitive to pressure call for the faradic current.

Cases of widely diffused and superficial neuralgic pains, with sensitiveness to pressure, as well as those belonging to the true type of neuralgias, are best treated by the galvanic current alone.

Electricity as a Means of Diagnosis.

Injury to a motor nerve is followed by certain anatomical changes associated with altered function as well as altered electrical reactions. There is always a very definite correspondence between the two, and in the ability to determine from the electrical conditions the histological state of nerve and muscle consists, in the main, the art of electrodiagnosis.

When a motor nerve is divided the muscles which it supplies are immediately paralyzed, and, no longer being in connection with their nutritive centre, the spinal cord, both nerve and muscle undergo pathological changes. Accompanying these changes are marked deviations from the normal electrical reaction of both nerve and muscle. *Immediately* after the section of a nerve there is often a temporary increase of electrical response to both currents when applied to the nerve or the motor-point of the muscle. Subsequently, however, there is a steady decrease in the readiness with which electrical reactions take place, until finally the excitability to both currents is completely abolished. These, it should be observed, are termed *quantitative* changes.

If the applications are made directly to the muscle, and not to the

nerve, we find quite a different set of phenomena. The faradic current, applied thus, acts very much as when it is applied to the nerve; not so the galvanic. When the latter is applied directly to the muscle, there is observed an immediate diminution in the readiness of response, but in a comparatively short time an increase of the electric excitability is developed. This is a sure indication that we still have healthy muscular fibre, but fibre deprived of its nerve-influence.

Soon, however, the muscular fibre itself begins to degenerate, and the galvanic current, instead of being followed by an increased readiness of response, acts upon the muscle less and less effectually, and finally, if regeneration in the nerve-structure does not take place, the galvanic irritability to muscle becomes extinct.

Accompanying this decreasing readiness of response are other changes in the character of the contractions, termed *qualitative*, or, as they have been called by Erb, the reaction of degeneration. If regeneration of the nerve and muscle should occur, galvanic reaction is also re-established, but fails to reach its normal standard for a long time. I have seen a number of cases in which the response of muscle to galvanism remained below the normal standard long after the complete return of voluntary movements and perfect response of nerve to faradism.

A case of facial paralysis that I have recently had illustrates many of the foregoing points. A week subsequent to the attack there was found to be marked diminution of response to both currents. On the tenth day or thereabouts there began to be a progressive increase of response to the galvanic current, but no abnormal reactions indicating degeneration of muscular fibre. These phenomena, however, began to appear at a later period, associated with a gradual decrease of galvanic response, and now neither current, when applied to the nerve, produces the slightest effect, while galvanism directly to the muscle causes only feeble and delayed reactions with currents as strong as can be borne by the patient. These observations illustrate in a very interesting manner the progressive anatomical changes that take place in an injured nerve, and the relations they bear to electrical phenomena.

The diminished reactions to both currents first observed when applied to the nerve indicated that the nerve-tissue itself was structurally altered, but did not necessarily indicate muscular degeneration. There occurred, on the contrary, increase of response to galvanism applied directly to the muscle, indicating that the muscular fibres were still healthy. This increase of reaction is said to be due to the deprivation of the inhibitory action of the paralyzed nerve, as well as the altered nutrition of the muscle itself. The reactions of degeneration which finally appeared, and still exist, together with the quantitative changes or decrease of response to both currents, indicate degeneration

of the muscular fibre itself, which may go on to a complete extinction of the electrical reactions. This indicates complete destruction of the muscle. As in the study of auscultation it is necessary to understand the normal action of the heart, so in the study of electro-diagnosis it is necessary to understand the order in which contractions occur in the healthy nerve and muscle when subjected to the "make and break" of the galvanic current. Bearing in mind that in health the closing contraction is always more vigorous than the opening, whichever pole is used, and that the cathode or negative pole acts more vigorously than the anode or positive pole, it is readily appreciated that there can be but four orders of contractions elicited in health, in the following order:

1st. The cathodal closure contraction, indicated by the formula C.C.C.;

2d. The anodal closure contraction, A.C.C.;

3d. The anodal opening contraction, A.O.C.;

4th. The cathodal opening contraction, C.O.C.

When, therefore, we speak of quantitative changes occurring in the electrical response, we mean simply that this order is changed, the A.C.C. being greater than the C.C.C., or the C.O.C. exceeding the A.O.C. These changes are also referred to as the "reactions of degeneration," and invariably indicate structural disease of muscular as well as of nerve tissue, while quantitative changes indicate degeneration of nerve-tissue only. This is an important point which it is well here to emphasize, for I find there exists a very general misapprehension in regard to it.

Qualitative changes in the electrical reactions are generally, if not always, associated with marked quantitative changes, while quantitative are often entirely independent of qualitative alterations. The one (quantitative) indicates more especially disease of nerve-structure; the other (qualitative) suggests degeneration of muscular tissue.

Such diseases as progressive muscular atrophy, pseudo-hypertrophic muscular paralysis, amyotrophic lateral sclerosis, and bulbar paralysis excellently illustrate degeneration of muscle with healthy nerve. In progressive muscular atrophy, for example, the electrical reactions demonstrate a healthy nerve, but a degenerated muscle. Either current applied to the nerve calls forth normal contractions. The faradic current, applied directly to the muscle, calls forth contractions according to the amount of healthy fibre remaining. The fact that it produces contractions at all demonstrates the integrity of the nerve-fibre, while the qualitative changes that are elicited on the application of the galvanic current to the muscle indicate the extent of the muscular degeneration. Similar phenomena are observed in the other diseases that have been mentioned in connection with progressive muscular

atrophy. The diseases, on the other hand, that show healthy muscle, but diseased nerve-tissue, are confined altogether to those of central origin.

These are paralysis from cerebral disease, and with few exceptions all those forms of spinal paralysis in which the gray matter of the spinal cord is not involved. Therefore, locomotor ataxia, the various forms of multiple sclerosis without trophic changes, and spastic paralysis are seldom, if ever, associated with qualitative changes. Quantitative changes are not infrequently observed in these spinal diseases, as well as in disease from cerebral lesion, but their causation is found in a general excitability due to an irritative lesion, to an absence of inhibitory action, or to atrophy of muscle through disease, and not to actual degeneration. In some nerve-trunk diseases, and also in acute affections of the gray matter of the cord, neither current applied to the nerve calls forth reactions.

Faradism to muscle gives no response, but galvanism to muscle is followed by normal or increased response. This indicates that both the nerve-trunk and its nerve-filaments are diseased, but that the muscle itself is healthy. These phenomena are of course observed only in the very earliest stages of the diseases mentioned, and in the nature of things must as a rule escape observation. Polio-myelitis anterior, on the contrary, whether occurring in the adult or in childhood under the name of infantile paralysis, and also lead palsy, uniformly yield those quantitative and qualitative changes that indicate degeneration of both nerve and muscle.

There are, again, still other forms of paralysis from spinal disease in which the character of the reactions varies widely according to the seat of the lesion. In myelitis, for example, the electrical reactions may be absolutely normal, indicating that the disease is probably confined to the antero-lateral or posterior columns, while in other and the majority of cases there are quantitative and qualitative changes that clearly point to disease of the gray matter of the cord.

An interesting deviation from the ordinary reactions found in diseased nerve and muscle, but one not very frequently met with, I imagine, is where both currents applied to the nerve or the motor-point of the muscle fail to produce any contraction whatever, while either current applied to the muscle directly calls forth reactions even more vigorous than normal. It is perfectly plain that this phenomenon means a diseased nerve-trunk, but a healthy muscle, with healthy intramuscular nerve-branches. As these reactions have been observed only in the very earliest stages of a traumatic injury to a nerve and in rheumatic neuritis, they would necessarily in most cases escape notice.

Methods of Electrical Application.

The main methods of electrization are five in number—viz. 1st. Localized electrization; 2d. Localized galvanization; 3d. General faradization; 4th. Central galvanization; 5th. Franklinization. These are of course subject to infinite variation in the practical details of their application; but a general description of each may prove sufficient as the foundation-stones on which to build experience.

Localized Electrization.—The art of limiting the excitation of the faradic current to certain organs and tissues is in the main due to Duchenne, a method quite as applicable also in the use of the sinusoidal current and the vibratory currents of the static electricity. He called attention to the fact that electricity could be localized under the skin if moist electrodes were firmly pressed upon the skin. He was led to this observation by the very familiar phenomena that follows the application of the dry electrode or hand to the surface of the body—viz. a crackling sound, but no sensation and no muscular contraction. This is due to the very slight conductivity of the skin. Through moisture, however, its conductivity is increased, and he observed that when wet electrodes were applied the same strength of current excited contractions immediately. This system, simple in its origin and detail as it may seem, has been refined and developed until it has grown into a permanent department of science. To be proficient in its use demands a certain amount of anatomical and physiological knowledge and manual facility; but its successful employment requires neither the dexterity nor care that is exacted by localized galvanization, general electrization, and central galvanization, nor the time and patience demanded by the last two methods. For these reasons localized electrization has been generally adopted by the mass of the profession, to the exclusion of the more advanced processes by which alone we can fully utilize the therapeutic powers of electricity. In carrying out the details of localized electrization the situation of the motor-points should be carefully studied. Ignorance of these points will involve waste of time in searching for them with electrodes in hand, and at the same time add to the annoyance of nervous patients. By placing the negative pole over the motor-point and the positive over the belly of the muscle, we obtain immediately the best possible contractions, whether for therapeutic or diagnostic purposes, with the minimum strength of current.

Localized Galvanization, especially when applied for the relief of pain, is a procedure of much greater delicacy than localized faradization. It was introduced to the profession more especially by Remak in a work *On the Methodical Electrization of Paralyzed Muscles,* by

virtue of which he became the founder of a school of electro-therapeutics in Germany, as Duchenne had been in France.

The term "stabile application" is employed when both electrodes are kept in a fixed position. The term "labile application" is employed when one or both electrodes are glided over the surface, without, however, causing any interruption of current sufficient to produce appreciable muscular contractions. When we desire to induce a purely sedative influence, it is of the greatest importance that the galvanic current should not only be free from any distinct interruption, but that every variation of current-influence, such as follows moving the pole along the skin, should be carefully avoided. At other times, however, it is desirable that our applications should be increasing, by which is meant that the current-strength is augmented with more or less rapidity without removing the electrodes. If the current is thus gradually increased, a much greater power can be borne than if it is suddenly let on in full force with the first closure of the circuit. A current which may produce unbearable pain, or, when applied near the nerve-centres, dizziness and faintness, may be borne without discomfort and with positive advantage if it is gradually increased from the minimum of current-strength.

Applications to the brain, eye, and ear especially, and to the sympathetic, spinal cord, urethra, and to all conditions of great irritation wherever seated, should always be thus gradually increased, and in the same way decreased. With the faradic current the management of these increasing and decreasing currents is very simple; but gradually to increase the galvanic current, especially if no rheostat is at hand, requires very great care.

Most galvanic batteries that are now made have an arrangement that gradually adds to the number of working elements without interrupting the current; but even with the greatest precision of manipulation breaks are apt to occur when least expected or desired, and it is far safer, therefore, to be always provided with some form of rheostat.

Labile or stabile interrupted currents are generally preferred for the galvanization of muscles, while for the galvanization of the head, spinal cord, sympathetic, nerve-tracts, and plexuses stabile continuous currents, either uniform or increasing, are, as a rule, indicated. In addition to their power to produce muscular contractions, labile or stabile interrupted currents cause more marked physical and mechanical effects, while stabile continuous currents, whether uniform or increasing, produce the stronger electrolytic and catalytic action. In applying the galvanic current to the brain it is well to remember that there is less tendency to dizziness if the negative pole is applied first and the circuit closed and opened with the positive pole. There are

many special effects of localized electrization, as of general faradization and central galvanization, but the leading and general results of all the methods is improvement in nutrition.

Localized electrization of poorly-nourished and atrophied muscles develops size and increases strength; localized electrization of any organ, such as the uterus, the nutrition of which has become impaired and its size diminished, tends to develop it and to increase its functional activity. In localized electrization these results are of course of a local nature; yet, owing to the fact that absolute localization is impossible, we not infrequently observe effects extending far beyond the parts actually enclosed in the circuit. By reflex action also we obtain remote effects which are either desirable or undesirable according to the demands of the case in hand.

Galvanization of the spine, and even of the extremities, may in certain irritable conditions excite the characteristic metallic taste. Galvanization, or even faradization, of remote and limited areas sometimes relieves pain, induces sleep, and increases the menstrual and other discharges through reflex influences alone. The effects of all local as well as general applications vary according to the length of the séances. The effect of the faradic current, when first applied by means of moistened electrodes, is to cause a tingling sensation, more noticeable at the negative than at the positive pole. In a short time the sensation becomes less and less marked, and a sort of anæsthesia is produced, enabling the patient to endure an increasing strength of current with no discomfort. The galvanic current, unless it be quite strong or directed over a motor-point, at first usually causes little if any sensation. In a short time, however, a slight burning sensation is experienced, rather more keenly felt at the negative pole. This sensation rapidly increases in acuteness until it may become absolutely unendurable; for, unlike the faradic current, the galvanic has not the same tendency to produce anæsthesia. There are two causes which probably account for this increase of pain, as well as of increased readiness of muscular contractions. The first is the fact that the conductivity of the skin becomes increased, not only through the moisture from the electrodes, but also through the greater activity of the circulation in the skin under the electrodes; and the second is the increased nerve-sensitiveness resulting from the stimulating effects of the current.

General Electrization.—When we administer general electrization with the faradic current it is termed general faradization. It is to this form of current that we now allude, although when a patient is placed on the insulating platform of a static machine or in a solenoid through which course currents of high potential and high frequency he is subjected to a form of general electrization. The object of general electrization is to bring the external portions of the body

from the head to the feet, and as far as possible the internal tissues and organs also, under the influence of the current. The galvanic current may be used in this way as well, but it is so rarely indicated that I have not included it in the enumeration of the methods of application. Its chemical and reflex influences are so potent that, excepting in cases of rare and remarkable insusceptibility to influences of all kinds, its effects would prove harmful rather than beneficial. It is very seldom indeed that a case is seen in which general electrization is indicated—that the faradic current is not sufficiently powerful, either directly or reflexly, to excite the physiological activities.

In order to bring the whole body thoroughly under the influence of the faradic current the feet of the patient should be placed upon a copper plate, to which the negative pole is attached. The soles of the feet are not at all sensitive to the current, but if the patient is especially nervous or susceptible the feeling of constriction that is experienced in the ankles as the current passes, and the occasional contraction of the flexors and extensors may become disagreeable and even hurtful. In this case it will be better to apply the negative pole by means of a broad, soft sponge near the coccyx.

The positive electrode may be either natural or artificial. The hand is the natural electrode, and those who are able to bear the requisite strength of current through their own persons, and are willing to subject themselves to the fatigue which follows its frequent use in this way, will find it unrivalled by any other form of electrode. It is not absolutely necessary that the hand be used, but it can be readily understood that no artificial electrode that human skill can devise can equal the hand in its flexibility and the readiness and completeness of its adaptation to every inequality of surface. In all applications to the head, eyes, and face, and in the more general treatment of acutely susceptible patients and hysterical women, one will fail in numberless ways to obtain the same results by any form of artificial electrode. Ordinarily, however, when the applications are made along the course of the spine, and over the abdomen and lower limbs, the strength of the current necessary is too powerful to be passed through the arms of any operator, and, fortunately, artificial electrodes answer here as good a purpose as the hand.

In submitting a patient to general faradization the operation should be with some regard to order. In the first place, the hair being thoroughly wet, the hand is passed with firm pressure over the entire surface of the head. In treating the forehead, which is far more sensitive to the current than any other portion of the body, the operator should first press his moistened hand firmly over the part, and then make the connection with his other hand on the sponge of the positive pole. The strength of the current when applied to sensitive parts of the body can

be sufficiently regulated by increasing or decreasing the grasp of the positive pole held by the right hand. An application of the faradic current to the head in many forms of neuralgia, nervous headache, and insomnia, if properly given, is capable of affording instant and most grateful relief.

There are few, however, who administer it with any degree of precision or skill, and as a consequence we witness aggravation instead of relief of pain. The slightest concentration of current in such situations as the forehead is capable of exciting pain even in the normal condition, while a proper diffusion over a broad surface, with equal and gentle pressure, affords a sensation as agreeable as it is curative.

The back part of the head and upper portion of the spine (cilio-spinal centre) will usually bear powerful applications; and it is an interesting and important fact that the applications to this centre will produce far greater tonic effects than when the pole is applied to any one other portion of the body. Care should be taken to avoid all bony prominences, since slight currents in these regions give pain. Hence over the scapula, clavicle, sternum, crest of the ilium, tibia, etc., care should be exercised in the moderation of the current. Let the first applications be tentative.

Experience will soon teach that there is no remedy to the effects of which there is such a varying degree of susceptibility as to this. A glance will not suffice, and frequently careful examination will fail to give information as to the proper strength and thoroughness of the treatment that should be first attempted. Not until the patient is submitted to a careful electrical test can we be sure that what we might consider very gentle treatment will not be too severe for the case in hand. As in the administration of localized galvanization, the current may be uniform or increasing. When the electrode is on the head, cilio-spinal centre, epigastric region, or pressed firmly on the various motor-points and nerve-plexuses, the current should be increasing. To make the applications successful, not only in the ultimate good, but also in that the patient experiences no subsequent weariness, soreness of the muscles, or vague but distressing nervous feelings, requires far more care and experience than is generally supposed. On the part of the operator is demanded a certain degree of mechanical dexterity, entire familiarity with the instrument required, a complete knowledge of electro-therapeutical anatomy, a personal acquaintance with the sensations and behavior of all portions of the body under the different electrical currents, and close and patient study of the diseases and morbid conditions in which they are indicated.

General faradization is, to me, absolutely indispensable in the practice of electro-therapeutics. Beginning with the method many years ago, and at first confining my manipulations in electricity almost exclu-

sively to it, I have not to this day seen cause to abandon its practice. There is no one tonic influence in medicine comparable to it in power; there is none to which can be accorded such a wide range of application; I can only account for its neglect on the part of those who profess proficiency in electro-therapeutics because of the time and labor requisite for its successful utilization, and the unwillingness of the physician to subject himself or his patient to trouble.

Central Galvanization.—By central galvanization we understand that method of treatment by which the whole central nervous system, brain, sympathetic nerves, and spinal cord, are brought under the influence of the galvanic current. To accomplish this, one pole, usually the negative, is placed over the solar plexus, while the other is firmly pressed on the top of the head and gradually passed over the occiput, along the inner border of the sterno-cleido-mastoid muscle, from the mastoid fossa to the sternum, and from the cilio-spinal centre down the entire length of the spine. For this method, which we first introduced and described a number of years since, is claimed a distinct and important position. The different applications to the head and neck which have been variously used since the time of Remak are simply forms of localized electrization; but in central galvanization, as is observed, the poles are so placed that the whole central nervous system is brought under the influence of one pole—usually the positive—without disturbing the other.

One reason that has been offered for rejecting central galvanization is the fear that its relations to electro-physiological laws cannot be fully explained. It is asserted that a remedy in order to be indicated in any special disease must have certain well-known physiological activities that directly meet or counteract the observed pathological conditions. To a certain extent this is true. For the relief of a dry skin and high pulse we resort to diaphoretics and arterial sedatives. To reduce the volume of blood in the brain we have bromide of potassium, and so on; but, on the other hand, can any one tell us minutely and satisfactorily why quinine has a controlling influence over the manifestations of malarial poison, why iodide of potassium tends to eradicate the syphilitic poison, or why opium causes sleep? And yet quinine is indicated in intermittent fever, iodide of potassium in syphilis, and opium in insomnia. That we cannot accurately localize the action of the current in limited areas of the brain has already been stated; but that external applications of the galvanic current penetrate directly to and appreciably affect it is thoroughly established, and the sedative and tonic effects that follow are well known to every one who has intelligently and thoroughly tested the method.

Central galvanization demands a far greater familiarity with the physics of the constant current, and with both functional and structural

derangements of the central nervous system, than is possessed by many who essay its use. If there is any one therapeutical process in the whole range of practical medicine that more than another defeats its own legitimate ends through careless and ill-directed or ignorant applications, it is this. As a matter of experiment we submit a person in robust health and with no marked nervous susceptibility to central galvanization. If the current is gradually increased and as gradually decreased, without interruptions, few if any unpleasant sensations are perceived. The metallic taste is decided, the head experiences a sensation of fulness, and if the experiment be prolonged or the electrodes small, itching and heat will be experienced at either pole, and on the head (the seat of the anode) slight pain of a dull aching character may possibly be felt. A second person, of increased nervous susceptibility, will experience an exaggeration of all these phenomena, and subsequently may suffer from severe headache. Because of the symmetrical influence which the galvanic current, by the method of central galvanization, exerts on the brain, little if any dizziness is perceived by even the most sensitive patients; if, however, the current be passed transversely through the head, the so-called falsification of the muscular sense that results from an unsymmetrical stimulation (one pole affecting the right and the other the left hemisphere) is the occasion of immediate and intense vertigo.

In thus transversely galvanizing the brain the hemispheres are differently influenced, and the result is a disturbance of the equilibrium. In conditions of health this dizziness, as a rule, passes off immediately on the removal of the electrodes, and is attended by no harmful results. In certain pathological conditions, however, and signally so when such conditions are associated with those peculiarly impressible nervous organizations that are so familiar, transverse galvanization of the brain is a highly culpable procedure. Let it be clearly understood, then, that in most cases this method should be avoided.

I might cite not a few suggestive cases, and not alone in my own experience, illustrative of the importance of this law; but it will perhaps suffice if I simply indicate a few guiding propositions. And, first, there is a certain class of patients, that I have just alluded to as being peculiarly impressible, who will in no degree be benefited by passing the current transversely through the brain; on the contrary, if there is mental or physical derangement from any cause, such application immediately aggravates the existing disturbance. In many instances there is no outward indication of any such susceptibility, and very frequently the most careful examination will fail to elicit a suspicion of any unusual relation of the nervous system to electrical stimulation. It is only when they are subjected to the test of actual treatment that idiosyncrasies are manifested that would not be distinctly revealed

by any other method. In two exceptional cases, for example, of which I have records a current of comparatively feeble tension caused an astonishing excitation of all the nerves of special sense. Sight, taste, smell, and hearing were perverted and exalted; and that these evidences of excitation were not the result of fancy I thoroughly satisfied myself by unerring tests. In these cases, as in a number of others that enter as factors into the experience that guides these observations, the after-effects were only less unpleasant than the primary, and were disagreeably persistent.

Now, observe the effects of applications by the method of central galvanization in the same patients. The same tension of current causes a decided metallic taste (but no vertigo and no ringing in the ears), with a slight feeling of fulness about the head; and persistence in this form of treatment resulted in decided relief. In consideration, therefore, of these facts we should be ever watchful for these susceptible cases, and to avoid errors of judgment that might prove unfortunate we should not presume even on the most extended experience, but should in the beginning pursue a tentative course.

In the second place, we have in cerebral effusion and softening, and especially in cerebral congestion, conditions that call for care in any method of galvanizing the nerve-centres. In old apoplectic cases transverse galvanization of the head has often been used with no unpleasant results. There can be no doubt, however, that it might in many instances prove exceedingly hazardous, and I have even seen unmistakable evidence of the ill effects (in producing dizziness and nausea) of an injudicious application of localized faradization in the neighborhood of the base of the brain and in the mastoid fossa. It is in the consideration of the symptoms of cerebral congestion, however, that we see most clearly the importance of rightly selecting our methods of electrical treatment. To give any direction to the currents excepting a longitudinal one (by which I mean from the summit of the head downward or from forehead to occiput) is, I believe, not only unphysiological, but contrary to the teachings of extended and carefully recorded experience.

In this connection, and especially with reference to central galvanization, an exceedingly important practical point arises concerning polar influence and current direction. Is the position of the poles or the direction of the current the more important factor in the production of therapeutical and purely physiological effects? The French school, and notably Legros and Onimus, denied the efficacy of polar influence in exciting physiological phenomena, ascribing them chiefly to current direction. They ascribed anelectrotonic effects to electrolytic action and to the induction of currents of polarization.

The contraction laws of Pflüger render it quite possible that in the

electrical stimulation of a given nerve-piece the polar influence has more to do with the resultant physiological effects than the direction of the current; and according to this theory the relative position of the poles in central galvanization (anode above and cathode below) would seem, on physiological grounds alone, to be chiefly indicated for the relief of symptoms of central origin. Experience, at all events, strongly confirms its propriety.

It is very certain that in many conditions, and especially in true neuralgia and spinal irritation, therapeutic effects vary according to the position of the poles. In central galvanization few facts are better established, to my mind, than that certain conditions, such as cerebral congestion and forms of hysteria, may be injured rather than benefited by what are termed ascending currents, but whether the ill effects are due to current direction or polar action I am not prepared to say.

Franklinization.—By franklinization is meant the application to the body of franklinic or static electricity. The simplest form of treatment is by insulation. In this method the patient is placed upon an insulating stool or table and connected with the conductors of either side according as a positive or a negative charge is desired. This silent reception of the electricity, and its silent and more gradual discharge from the body to the surrounding atmosphere, produce in most persons very pleasant effects. The hair of the head rises up, accompanied by an agreeable sensation, as if the wind were playing gently around. The pulse may be slightly accelerated and the face become flushed, while after a time it is occasionally observed that a slight but general perspiration appears. This condition may frequently be kept up with advantage for twenty minutes or so, until an agreeable feeling of drowsiness is experienced.

In the treatment by sparks or spray the patient is first put in the condition of insulation just described. Sparks can then be drawn from any portion of the body by the near approach of a conducting substance. Brass balls of various sizes, mounted on glass handles held by the operator, connected by a brass chain with the ground, or, better still, with the nearest gas- or water-pipe, are usually employed. As a substitute for general faradization, although by no means so generally effective and far less agreeable, the metallic roller may be used. It acts reflexly and excites the cutaneous nerves most decidedly. When the roller is used upon the bare skin the conduction is so perfect that no sensation is appreciated. It is only when the clothing intervenes that the peculiar pricking sensation is observed. It is needless to say that to obtain the best therapeutic effects of the roller it should be applied over the clothing. The electric wind, so called, following the use of the pointed electrode, is due to the agitation of

the air between it and the person treated. The discharge is silent and the effect exceedingly agreeable and refreshing.

Vibratory Method.—In its simplest form this is an electrification with an oscillatory instead of constant static charge. Without doubt it has a more energetic effect upon nutritive processes and the general nervous system than the usual uninterrupted insulation. Besides a general vibratory treatment, this method is employed in various local applications. In its local application, however, this method can hardly be called new in principle—since it merely adopts the old idea of breaking the current by a spark elsewhere than on the patient. It is this succession of vibratory waves that are utilized in wireless telegraphy. The patient is insulated or not, and direct metallic connection made with the positive pole of the Holtz machine, to secure the full power of the current. The negative pole is connected with the ground, and when the machine is put in action powerful but absolutely painless oscillations are developed. By means of plates of blocked tin or flexible sponge electrodes the application can be readily made to any portion of the body.

Treatment by Shock.—This is a violent method, and not usually called for. It is produced by bringing the body, or that portion of it on which we wish to operate, in the circuit between the outer and inner coating of the Leyden-jar attachment. In addition, a static induction current has been suggested as a substitute for faradic electricity. It is claimed for this current that it produces maximum muscular contractions with a minimum amount of pain, and that the response is quicker than that from the faradic current. As for the first claim, it is difficult to see how it can be determined, since the ordinary faradic current, from the single-coil apparatus especially, need seldom call forth pain in the production of muscular contractions. The change in the apparatus for the production of this current is quickly and easily effected, and for the purposes of localized electrization is most valuable. For general faradization, however, I can quite confidently assert that it is inferior to the current produced by the best faradic apparatus. That it possesses certain advantages, however, over the faradic current cannot be denied. Its voltage is enormous, and the alternations of each spark so rapid (millions per second) as necessarily to give it precedence in many respects over the ordinary induction current.

In order to obtain this current it is necessary to hang a pair of Leyden jars, as seen in the illustration, upon the arms of the machine. As the strength of the current is modified by the size of the jars, it is well to have several sets of different sizes. Rheophores to which ordinary sponge electrodes are attached are joined to the hooks that rest upon the outer coating of the jars. The strength of the current is in

direct proportion to the distance apart of the two knobs of the discharging rods. These, therefore, should approximate closely at first, and be separated gradually as a stronger influence is desired.

The absolute value of franklinic electricity as a therapeutic agent is, without question, very great. Its relative value cannot be estimated with the same readiness, since conclusions on this point render it necessary to compare its effects with those of dynamic electricity. Any arguments, therefore, in the direction of showing that franklinic electricity has greater claims upon us as a remedy than has been generally believed must, of necessity, be quite valueless unless they are based upon long and thorough use of the different forms of dynamic electricity, especially by the methods of general faradization and central galvanization. The difficulty of obtaining reliable and exact information in regard to this matter will undoubtedly lie in the fact that in the future as in the past clinical reports will be too often given by those who have had no systematized or adequate experience in the use of dynamic electricity.

Sedative and tonic effects of a very interesting character are undoubtedly obtained through franklinization, but these effects are hardly equal in variety or degree to those that follow the careful and thorough use of dynamic electricity by the methods above mentioned. None the less, however, do we hail the recent revival of this neglected department of electro-therapeutics, not only because in certain conditions it may possess some advantages, but because, through peculiar idiosyncrasies, it is sometimes better borne than the other forms. It must not be forgotten, however, that, as a rule, general faradization is far more agreeable than treatment by sparks, however carefully given. Those who assert to the contrary do so through lack of experience or skill in the general method of administering faradism.

Of all the approved methods of using electricity, franklinization has the advantage of requiring the least skill and experience in its administration, and the disadvantage of necessitating apparatuses that are cumbersome, expensive, and not in the same degree reliable as the instruments for the generation of dynamic electricity. A still further advantage lies in the fact that little if any disrobing is necessary, since the drawing of sparks and the general stimulation of the surface are accomplished through ordinary clothing.

Another important reason for the use of franklinic electricity—and one which, to my gratification, I have thoroughly tested—is its occasional value in supplementing and reinforcing the constitutional tonic effects of general faradization.

It is one of the familiar things in medicine that a remedy which at first acts most effectually may, after a time, cease to have the desired effect. If, now, we substitute a remedy of the same class, even though

it be inferior, further benefit often follows, and upon returning to the original treatment it acts with renewed vigor. The same principle holds good in regard to the dynamic and static forms of electricity. Occasionally cases of nervous exhaustion, as well as other forms of disease, after improving up to a certain point under the influence of galvanism or faradism, hang fire, as it were; but by submitting the patient to the action of franklinization a new impulse seems to be given. In this way, one treatment supplementing and reinforcing the other, results are obtained far more satisfactory than could possibly follow the exclusive use of general or localized faradization, central galvanization, or franklinization.

Currents of High Potential and High Frequency.—While the static induced current alluded to in the preceding pages is a current of high potential and high frequency, the physiologic and therapeutic effects of this manifestation of electricity has been more closely studied of late by the use of a Ruhmkorff coil run by a continuous current of great intensity. The internal coatings of two Leyden jars are connected with the two ends of the coil, while the external coatings are united by a solenoid sufficiently large to enclose the entire body. The influence exerted upon the excretory and secretory processes—entirely painless and without sensation—is quite marked. The urine if deficient is almost invariably increased in quantity, while combustion is accelerated, as shown by a decrease in uric acid and an increase in the amount of urea eliminated. There is also increased heat radiation, but without any rise of body temperature.

Combined Electrization.—By combined electrization is meant the simultaneous application through the same electrode of the two forms of dynamic electricity, the galvanic and faradic currents. On account of the inefficiency of apparatus and the difficulty of utilizing the combined currents, the method was long held in abeyance, but since the introduction of new and improved mechanisms this form of treatment has been tested with some degree of thoroughness and found to be of considerable value. That the faradic modifies somewhat the action of the galvanic current is evident from the fact that the milliampèremeter registration during the simultaneous use of the two currents is somewhat greater than when only the galvanic is being applied. The explanation suggested is, that the resistance of the body is immediately lowered by the passage of the faradic current. If it is not always an easy matter to differentiate in the use of the different forms of electricity, it is even more difficult to decide as to the relative efficiency of the galvanic alone, and in combination with the faradic. Galvanization relieves pain, and so also does galvano-faradization or combined electrization; but that the

latter will not only relieve pain, but succeed in other therapeutic ways where the other fails, or is only partially successful, my experience does not permit me to doubt. One of the most satisfactory proofs of the efficacy of the combined currents was afforded by several recent cases of rheumatoid arthritis, for which previous treatment by electricity had accomplished little or nothing. The right knee-joint in one case had been inflamed for many months, resulting in probable degenerative changes and marked deformity, while the pain was so constant and severe as to prevent sleep without the nightly use of an opiate. Galvano-faradization simply to the point of easy endurance afforded immediate relief, and its persistent use so improved the patient in relieving tenderness and swelling that he was enabled to sleep without an opiate, and could bear a very much greater weight upon the knee. He could even walk short distances, a thing he had been unable to do for more than a year. In exophthalmic goitre, where the galvanic and even the faradic currents have so often proved beneficial, I have with the combined currents succeeded in several cases, after only partial success with the usual methods. The combined currents act both mechanically and chemically upon the thyroid body and its nerve supply. If therefore we accept the familiar theory that Basedow's disease is a disease of the thyroid rather than of the nervous system primarily, and that the symptoms complex are due to the production in the thyroid of some toxine which acts on the whole nervous system, the rationale of the apparent superiority of the combined currents over the single current in this disease would seem to be even clearer than if we ascribe the symptoms to the nervous system alone. Combined electrization is of special value in stimulating the phrenic nerve, and consequently is more effective in the production of artificial respiration than either of the two currents alone.

Electricity in Nervous Diseases.

The scope of this article does not permit of any discussion of the relation of electricity to that very numerous class of diseases, the functional neuroses. In studying the physiological activities of electricity we are irresistibly led to the conclusion that its therapeutical action must be more especially in the direction of the relief and cure of nervous diseases. Experience thoroughly confirms this conclusion, and therefore he who makes much use of electricity in medicine will necessarily carefully study the neuroses. Much fault has been found with electricity because it fails to cure the graver forms of organic diseases of the nervous system; but it may be asked, Is there any therapeutic agent that will do this? As a rule, we use electricity in this class of affections

for its symptomatic effects, and by relieving pain, paralysis, spasm, anæsthesia, and a variety of other symptoms much good is accomplished.

Electricity is essentially a stimulant, an exciter of living tissue; and whether the excellent results that follow its use in deep-seated structural diseases are due to its direct influence upon the diseased parts or to the peripheral impressions that it registers makes but little difference. Limited, therefore, as its value is in the graver forms of structural disease of the central and peripheral nervous system, it not infrequently acts with extraordinary efficiency in some of these cases, and gives rise to expectations in succeeding cases that are too often far from being fulfilled.

Electricity, however, has wrought its best results in neither central nor peripheral nerve-lesions, but in the variety of nervous disease rather that in our ignorance we have termed "functional."

Because we do not understand the pathology of functional neurasthenic disease, and are still unable to appreciate the errors of nutrition that undoubtedly underlie all these cases, it is no reason why we should not persist in the use of a remedy that has been of such splendid service in their relief. It has been said by Erb that we might as well do away with the bromides and arsenic in functional nervous diseases because we do not understand the theory of their action, as to abandon electricity because of our ignorance of the laws underlying its influence.

Electricity in Gynecology.

Until a recent period the advances in the therapeutic uses of electricity were more especially along the line of those distinctively nervous affections that were neither specific nor structural in their nature. Cases of this latter type have always yielded but meagre results under electrical treatment, and I do not know that any competent authority seriously claims for electricity in most cases of structural disease of the central or peripheral nervous system more than temporary and palliative effects. And yet those who, arguing on the side of their prejudices or out of the fulness of their ignorance of the subject, ascribe to electricity a very low place in therapeutics do so mainly on the basis of its failure to cure a class of conditions incurable by any method of treatment. The statement that as a therapeutic agent "the effects of electricity are limited" must indeed seem a rash observation to those who have repeated evidence of the wide range of its influence in the relief of nervous symptoms, and especially so to those who have witnessed the really remarkable relief so often afforded by both extra- and intra-uterine applications of the galvanic current. When a man possessed of the experience of Keith of Edinburgh can say that many are prejudiced against electricity because they consider it quackery, and know nothing

about it; that his confidence in its power to relieve disturbing symptoms of fibroid tumors and to cure many chronic inflammatory conditions of the pelvis continues to increase; and that he has no fears for the future of electricity,—we have testimony that must greatly outweigh assertions and opinions that are purely negative. In a recent and animated discussion of the subject at the Société de Chirurgie of Paris equally favorable opinions were advocated by the majority of those engaged in the debate, and the strength of these opinions was accentuated by the fact that the majority of those who hold them are signally distinguished as laparotomists.

Static electricity has a limited range of usefulness in diseases of women compared with the two forms of dynamic electricity. By the ordinary methods of its application it acts as a stimulant and tonic, and is therefore of service in amenorrhœa and in the various constitutional disturbances so generally associated with uterine disease. In dealing with the other two forms of electricity I do not propose so much to give the results of my own experience in gynecological electro-therapeutics as to allude briefly to some points in the rationale of its effects, and to offer some practical observations on the methods to be employed.

The effects of the faradic current are mainly mechanical, and according to the construction of the helix and the length and thickness of the wire do we measure its action on the muscular tissues of the uterus. Applied directly to the uterus of animals in physiological experiments, the organ visibly contracts, although not to such an extent as do the intestines, which on application of the electrodes can be seen to draw up gradually very much after the manner of a woman's work-bag. Its action on the smooth muscular fibres of the human uterus when applied therapeutically is analogous to that of ergot, although manifestly more prompt and energetic, especially under the influence of the positive pole, which possesses a much greater power over the involuntary muscles than the negative. It is a current of alternation, of constant closing and breaking, hence it produces a sort of interstitial massage, heightening the activity of the circulation, accelerating absorptive processes, and influencing favorably the nutrition of parts.

Faradization by its power over muscular contractions sensibly increases temperature. According to the chemistry of the development of heat during muscular contractions, muscular work is the result of the decomposition of nitrogenous substances, and the muscles grow at the same time that they work and develop heat. That the value of the faradic current is more limited than the galvanic in the treatment of uterine disease must be immediately manifest to all who appreciate the difference between them, but in some conditions which come within the range of its physical and physiological activities the faradic current may exceed in efficiency the galvanic. By its direct excitation of the

smooth muscular fibres of the uterus we are enabled to combat that stasis of the circulation which is the beginning of uterine inflammation.

By this method we obtain a veritable interstitial massage that is potent in overcoming the primary inertia of the organ, and in preventing an arrest of retrograde metamorphosis, through which comes subinvolution with its inevitable and persistent sequelæ. In its purely local influence, then, faradization would seem to be preventive rather than curative as it relates to uterine disease; or, rather, it is preventive so far as concerns the later condition of uterine engorgement, and curative only in its initial stage. When the processes that go to make up the graver and more chronic diseases of the uterine parenchyma and its lining membrane have continued a long time, as is usually the case when medical interference is sought, the simple mechanical effects of the faradic current would be altogether misdirected.

Here we resort to the electrolytic influence of the galvanic current, or rather to what may be more fitly termed its galvano-chemical cauterizing effects, through which are destroyed the granulations and fungoid growths of the diseased mucous membrane. By the interpolar influence of the current we correct a languid nutrition and hasten the absorption of exudations.

In considering the many excellent and curative effects of internal applications of the faradic current we should not lose sight of the fact that external applications alone are frequently most efficient methods, especially for the relief of the disorders of menstruation. When we remember that in young girls it is neither desirable, nor in many cases possible, to administer internal treatment, the importance of having at command external methods that may prove serviceable is readily appreciated. Electricity is not merely a stimulant, but may be made to act as a powerful constitutional tonic. Under certain conditions its action also is sedative, and these effects of sedation and improvement in nutrition are far more important than its stimulating effects. As in many of the diseases peculiar to women, it is of prime importance to improve both the local and general nutrition and to produce not only stimulating but sedative effects, the method of general faradization plays no unimportant part in the treatment of diseases of women, and especially, for reasons just stated, in the treatment of the disorders of menstruation occurring in young girls.

Electricity is no exception to the general law that in order to obtain the constitutional tonic effects of a remedy the whole system must be brought under its influence. It is not a whit more irrational to expect one to appreciate the full tonic effects of cold water by washing one arm only than it is to expect the full effects of electricity by using it locally. Experience here confirms analogy, and teaches that

the constitutional effects of electricity can only be obtained by making the applications all over the person and to the central nerous system.

The results of these methods are variously modified according to the conditions of disease or special idiosyncrasies of the patient. Many, and perhaps the majority of, patients subjected to thorough general applications experience a feeling of enlivenment and exhilaration. In others the tendency may be to sleep, and in such cases the patient should be permitted, and even enjoined, to quietly repose for some time. Because of this disposition to sleep which is so often observed it becomes in many cases desirable, especially when insomnia is present, to administer the applications at night before retiring. The relief from indefinable nervous pains and from general and local weariness is a very agreeable temporary effect of general electrization. Sometimes this feeling of relief lasts for several hours, and at other times for a much shorter period, but in either case persistent effort will, as a rule, result in more or less permanent benefit.

Now, in those cases of amenorrhœa, dysmenorrhœa, or menorrhagia where it is impracticable to attempt internal methods of treatment we can with confidence offer a favorable prognosis only on the assumption that no serious pathological condition prevails, and in the vast majority of cases of amenorrhœa occurring in young girls it is not at all probable that any such important pathological condition exists. Most of these cases are probably associated with, and more or less dependent upon, chlorosis or nervous exhaustion, and the important thing is not to specially stimulate the uterus, but to change the constitutional condition which is the cause of the suppression of the function. Accordingly, the treatment by general electrization, combined with such internal medication as may be specially called for, is generally sufficient without applications directly to the uterus. Indeed, the majority of cases of functional disease of the uterine organs require general as well as localized electrization.

In any case of amenorrhœa where the patient is weak and anæmic, with other and well-understood evidences of malnutrition, the faradic current or the high potential high frequency currents are strongly indicated over the galvanic. As already stated, the applications should be general, although the local treatment, when permissible, is always in order and undoubtedly hastens the desired effect. Localized galvanization is, as a rule, not only not indicated in such a condition, but in many cases, as I have had abundant occasion to observe, tends to induce a condition of nervous irritation that is exceedingly unpleasant. In amenorrhœa either pole when applied to the uterus may be followed by the best results. The negative, in the subjective sensations that it causes, is the stronger, but the positive is decidedly prefer-

able in some cases, because its tendency is to more readily contract the involuntary muscular fibre. In the treatment of neuralgic dysmenorrhœa, where the faradic current is sometimes of value, the positive pole locally applied is undoubtedly preferable. On physiological grounds alone this conclusion might readily enough be reached, but unfortunately electro-physiology is as yet but a very uncertain guide in many cases. I have therefore for years carefully observed and as carefully recorded the differential effects of the poles in this condition, and have become convinced that the average results are superior when the positive pole is used.

On the same principle that we use general electrization in cases of amenorrhœa associated with, and perhaps dependent upon, a weak, chlorotic condition of system, we make applications of it where similar symptoms are associated in the menorrhagic subject. In not a few such cases I have known simple external treatment by this method to be followed by complete and permanent cessation of the excessive flow, and a corresponding improvement in appearance and strength.

The local treatment of the uterus and its appendages may be either external or internal. The external treatment consists simply in placing one pole in front, over some portion of the abdomen, according to the indications of the case, and the other over the lower lumbar region. This method is frequently of great service in the disorders of menstruation, and in the case of virgins should certainly be attempted before resorting to the internal method.

The localization of the current in the organ in this way is, of course, only partial, and far less effective than internal applications; while the benefit derived is undoubtedly in part due to the effects of the current, at least of the galvanic current, on the lower part of the spinal cord and the abdominal ganglia of the sympathetic.

The internal treatment of the uterus and ovaries by the faradic current may be effected in two special ways. 1st. By the uni-polar method. The internal electrode may be applied either to the cervix uteri, to the interior of the uterus, or in the rectum, while the other is applied externally, either at the nape of the neck, near the sixth cervical vertebra, over the lumbar region, or, as is most generally the case, over the abdomen. Applications to the cervix are made by means of an insulated electrode with a metallic bulb, or, instead of the bulb, small plates may be used to clasp the os. The vagina may be treated by a straight or slightly curved metal electrode. It is an interesting and important fact to be borne in mind that internal are relatively far less painful than external applications. Very many, therefore, in first attempting this method of treatment are surprised that the sensations under the broad surface of the external electrode are complained of more than those at the point of contact of the small internal electrode.

In uterine displacements the faradic current by the uni-polar method has accomplished some good. The rationale for its use is indeed so clear that from the standpoint of theoretical considerations alone one might be pardoned for regarding it as almost a specific in this class of cases. The two most important factors that make up the value of electrical applications in displacements are probably the hyperæmia, and especially the contraction of muscular fibre, that follow its use; and as the contraction of a muscle determines the amount of its nutrition, it follows that if a current of electricity is localized in a given point of the uterus, that part will contract, its nutrition be improved, and at the same time counteract any flexion in the opposite direction. It must be confessed, however, that even in experienced and competent hands the results of electrical treatment in this special field have not equalled the brilliant promises of some of its ardent advocates.

The simplest, and probably least efficacious, method is to introduce one electrode behind the os uteri, while the other is applied externally over either the pubes or sacrum. A more effective localization of the current is accomplished by introducing one electrode into the uterus, while the other is placed externally; but more effective than this is the internal use of both poles, still by the uni-polar method. In cases of anteflexion one pole, the curve of its stem corresponding to that of the sacrum, is introduced into the rectum up to the point nearest the posterior wall of the uterus. In this way the current is quite accurately localized in the posterior uterine wall, causing contraction and improving nutrition. In retroflexion the first electrode, instead of being passed into the rectum, is introduced into the bladder and applied to the anterior wall of the uterus. When the faradic current is used—and this form is chiefly indicated—the relative position of the two poles would seem to be of no special importance, although for the intra-uterine electrode the anode may be preferred, on the theory that it has a greater power over unstriped muscular fibre. Tripier, however, recommends that the negative pole be placed in the uterus. The pain is sometimes considerable, and is due to two causes: first, the concentrated action of the electricity on the mucous membrane; second, the contraction of the uterine fibres. In other cases very little discomfort is produced. By beginning with a very weak current and gradually increasing it, a much greater strength can be endured than if this precaution is not observed. In this connection it may be pertinent to the subject to say that when voluntary muscles are subjected to the action of the poles of either a galvanic or an electro-magnetic battery, contractions instantly occur. These contractions continue, as is well known, during the passage of the faradic current, but quickly relax after the first shock of the galvanic. When, on the contrary, involuntary muscular fibre, of which the uterus is composed, is subjected to

the influence of the electric current, movements are not induced until a certain time after the tissues have been acted upon. The movements thus excited continue for a time after the cessation of the current, and do not, as in the case of voluntary muscles, cease as soon as the electrodes are removed. The most efficient action, however, of the faradic current upon the uterine tissue is through what is known as the bi-polar method. In this method both poles, the positive and negative, are combined in a single electrode, constructed either for intra-vaginal or intra-uterine applications.

The physiological and therapeutical effects of the faradic current vary greatly according to the construction of the helix, and many of the machines that are sold for medical purposes are of limited value. The galvanic current, on the contrary, varies but little in its sensible effects whatever form of battery is used, and in the selection of an apparatus the question is not as to the character of the current, but relates more to matters of convenience and constancy. The two forms of faradic apparatus in general use are what are termed the separate and the continuous coil. The separate-coil apparatus is almost universally composed of only two distinct coils, the primary and the secondary, although those who use electricity to any great extent in gynecology utilize a third coil of exceedingly long and fine wire. The primary coil, with its short, thick wire, gives a current of exceedingly low tension, but of considerable quantity, while the longer and thinner the wires, up to a certain point, the greater the tension and the less the quantity.

Externally used in the ordinary methods of electrization, the currents of quantity produce little if any effect. Their tension is so low that it is with difficulty that the current can force its way through the great resistance of the skin. The currents of tension, on the contrary, readily overcome the resistance of the skin, and are adapted for all external treatment. When, however, we apply the currents internally, even by the uni-polar method, a very great change is observed in the efficiency of the currents of tension and of quantity. The former, even if used with all the power that an ordinary battery is capable of giving, seldom causes pain or very violent contractions, and after a few moments of application absolutely no sensation may be experienced, and both physician and patient may be in doubt whether any electrical action is taking place. Just as the current of tension acts with apparently decreased vigor when applied to the vagina, uterus, and other internal parts of the body, the currents of quantity seem to double their energy and to produce both sensation and contraction of a very positive character. Substitute for uni-polar the bi-polar method, and the contrast is far greater. A current of quantity which when applied externally makes absolutely no impression, and even when applied internally by the uni-polar

method is felt with little vigor, causes, when passed through the poles of a bi-polar electrode, the most vigorous contractions and positive sensations. The continuous-coil apparatus, in that it affords a wider range of electrical effects with its four distinct qualities of current of quantity and tension, is to be preferred in gynecology as well as for general therapeutic purposes.

These currents of quantity, when applied internally through a bi-polar electrode, should be used with caution. The extraordinary vigor with which they act upon the vagina, uterus, rectum, or bladder, compared with the exceeding mildness of their action when applied externally, will hardly be credited without actual demonstration of the fact.

The physiological effects of the current of quantity indicate in a measure what its therapeutical effects should be, and also the pathological conditions for which it should be used. Primarily, it is a powerful stimulant and tonic for muscular fibre, and when there is defective muscular contraction it is often used with the most marked success. In post-partum hæmorrhage it is invaluable, and has the advantage over ergot that it acts simultaneously and can be readily graduated, so that the power put forth shall be just sufficient to accomplish the object sought. It is in the beginnings of uterine disease that the faradic current is especially valuable, and if used promptly and judiciously after confinements and abortions when subinvolution is threatened it will prevent much subsequent trouble. "We no longer ignore the fact to-day that the great majority of uterine inflammations, probably of septic origin, are due most frequently to an arrest of the retrograde metamorphosis of the uterus, that they are created entirely by uterine subinvolution, and that the circulatory troubles, characterized by congestion and stasis, preside over their initial evolution. If the physician interferes, then, by removing obstruction and sepsis at the same time, producing a passing hyperæmia, a sort of circulatory drainage, if he combats the primary inertia of this organ, the slowness of the circulation of which gives rise to all the subsequent inflammation, he puts in an excellent treatment which prevents and cures at the same time. Such is the rôle of faradization, which, applied in the uterus in the proper manner, preceded and followed by an antiseptic injection, produces a sort of interstitial massage, provokes the contraction of all the smooth muscular fibres, excites and hurries the circulation, accelerates the absorption of exudations, and so corrects a languid or perverted nutrition."[1]

In fully-developed subinvolution the benefit that follows bi-polar faradization with the current of quantity has, in my own experience, been positively and promptly indicated. The current of tension from the long, thin wire of the helix possesses an altogether different func-

[1] *Chronic Metritis*, by George Apostoli, translated by A. Lapthorn Smith.

tion. It possesses but a limited influence over the contractions of the uterine tissues, and is manifestly inferior to the current of quantity in its influence over the circulation. It affects the nervous system powerfully, however, and possesses an influence over pain that is in some instances little less than magical. The best results that are obtained in uterine and ovarian pain undoubtedly occur in cases unassociated with organic lesions. In these cases the relief is often prompt and permanent, but even in severe forms of pain dependent on or associated with structural uterine disease, the relief afforded is often very great. In cases of ovarian pain it is manifestly impossible in many cases to say whether the ovaries themselves are diseased or not, and it is most unfortunate that they should ever be removed without first testing the efficacy of either the galvanic or the faradic current of tension, both of which play such an important rôle in the relief of pain. It is within my own experience that after both ovaries had been removed for the relief of ovarian pain, but without avail, the galvanic current succeeded in effecting a complete and permanent cure.

Valuable as is the faradic current of high tension to prevent, and even cure, uterine and ovarian disease, it occupies in many respects a quite different field from that of its fellow, the galvanic current. In the use of the first named we depend mainly upon simple mechanical and stimulating influences, while in the use of the other we rely upon its electrolytic influences, or rather on what may be more fitly termed its galvano-chemical cauterizing effect, through which are destroyed the granulations and fungoid growths of the diseased uterine mucous membrane. Just as the positive pole of the faradic current has an action of its own superior in effect to the negative in causing uterine contractions, so the positive pole of the galvanic current has an action peculiar to itself. Here oxygen is generated and acids accumulate, which render this pole directly hæmostatic. It is therefore indicated in all hæmorrhagic conditions, as well as where there exists an excess of the natural secretions. Owing, also, to the greater retractibility of cicatrices following positive galvano-cauterization, the results are more lasting in the treatment of fungoid growths or vegetations than could possibly be the case with the negative pole.

At the negative pole, on the contrary, the alkalies precipitate, imparting caustic properties and causing effects fluidifying rather than hæmostatic. The absorptive process is undoubtedly more active under this pole than under the positive, and is especially indicated in indurated chronic metritis and for the resolution of fibroids.

That the galvanic current often completely dissipates fibroid tumors of the uterus few will, I believe, affirm. In the treatment of scores of fibroids on the external surface of the body I have never yet seen a

single instance where one of them completely disappeared. As a rule, the reduction is comparatively slight, unless suppuration is excited, which may be easily done. External fibroids are simply unsightly, and for this reason we desire to be rid of them, and as it is not possible to obtain more than a reduction in size, the knife is to be preferred and electrolysis has fallen into disuse. We treat uterine fibroids, on the contrary, not because they are unsightly, but because associated with them are a train of symptoms sometimes of the most distressing character. These symptoms can, it is believed, be relieved to a greater or less extent by electrolysis, and sometimes so completely relieved as to lead to the belief, so far as the patient is concerned, that the tumor has entirely disappeared. In the great majority of cases, however, it is simply a symptomatic cure. The tumor is still there, but reduced in size, and so far as pressure upon surrounding parts is concerned, or any hæmorrhagic tendency, is entirely harmless. I am a firm believer in the great utility of the galvanic current in the thickenings and infiltrations resulting from inflammation of the pelvic cellular tissue. For the absorption of old exudations in other parts of the body this treatment has long been used with excellent results, and in pelvic exudations the results are even better. I have seen the treatment, persistently carried out, result not only in the absorption of large pelvic deposits, but in the cure of the most obstinate and severe sciatica and in the restoration of power to partially paralyzed limbs. In such cases both sciatica and paralysis are caused, undoubtedly, by pressure upon the pelvic floor, and can be relieved only through the dissipation of the morbid products.

There are two methods of action through which we obtain results from electrolysis. The first and most apparent is the absolute destruction of tissue which takes place at the time of treatment. Some suppuration may follow, and thus, by an actual loss of substance apparent to the sight, the tumor decreases in size. If, however, these were the only active forces in the electrolytic process, the method would lose much of its effectiveness.

If this be not so, how can we account for the many well-attested cases where morbid growths have entirely disappeared under simple external applications? Herein is the difference between the electrolysis of organic and inorganic substances. In the electrolysis of inorganic substances the effects cease as soon as the current ceases, the substances remaining in the condition that the current left them. The electrolysis of organic substances, on the contrary, starts a process that continues long after the current ceases to flow. Besides this subsequent effect, the current penetrates the tissue and induces various important changes beyond and beneath the eschar, and these combined agencies do far more, in many cases, to diminish the size of morbid growths and

prevent further development than an actual destruction of a limited area.

The methods and technique of gynecological electro-therapeutics have been only recently developed and are still developing. Most extravagant and unreasonable estimates of its efficiency have been held by the more enthusiastic, while the extreme conservatism of many eminent gynecologists would relegate it to a comparatively unimportant position in the treatment of uterine and ovarian disease. Adverse opinions upon this interesting subject, when based upon thorough and well-directed experience, are of value and altogether indispensable; but when there is no experience behind opinion, or an experience that has been guided by no clear insight into the law of physics and technique of methods, opinions, either for or against, are manifestly worthless.

Thus would I estimate the opinion of men, otherwise most competent in the line of gynecological work, who discourage the use of electricity by the newer methods for the relief of conditions in which the curette or knife alone were formerly supposed to be efficient. These newer methods, first introduced, as is well known, by Apostoli, are special and unique, and ignorance in their use must account in some measure for the failures to obtain the usual results, and necessitates a brief physical introduction and a description of apparatus and secondary appliances essential to conduct experiments in this direction.

1. *The Battery.*—At the outset let it be understood that so far as the physical and physiological and chemical effects of the galvanic current are concerned, it is immaterial what form or size of cell is used or whether cells are discarded and the ordinary low tension street current used. In cities and large towns this latter is coming more and more to be utilized. In view of the discussions that even now arise in medical societies, among men who are supposed to be proficient in regard to this subject, concerning the superiority of the effects of this or that element, this statement is a pertinent one. No matter what the origin of the galvanic current —whether from large or small cells, from the voltaic pile or from the huge dynamo with which our streets are lighted—the kind of work is always the same according to the electro-motive force and the resistance in the circuit. Electro-motive force is one, and Ohm's law is our only and infallible guide, and attempts to prove the superiority of this or that kind of element, except on the ground of constancy or convenience, is useless. While this is true of the galvanic current, it is by no means so with the faradic, the causes of which will be found explained in the previous pages of[1] this article. To do thorough satisfactory work with electricity in gynecology the practitioner should have at command an electro-motive force of about seventy-five volts. He

can do with less than this in most cases, but occasions occur when the whole number will be required. As constancy is a very essential point in the treatment of this class of cases, the ordinary single-fluid cells should not be selected. As they have but little internal resistance and a fair electro-motive force, it might be supposed that they would answer every purpose; but as they have no satisfactory provision for depolarization, the hydrogen that collects upon the plates soon lessens the current to the detriment of the treatment. For constancy the Daniels is the ideal cell. It gives an electro-motive force of one volt, and even when short circuited will retain its constancy for a length of time sufficient to utterly destroy most other batteries. The fatal objection to it, however, is the readiness with which the liquids in the cells are diffused through the diaphragm, requiring frequent recharge. The Leclanché —or the Law cell, which is a modification of the Leclanché, and in some respects to be preferred to it—is not constant in the sense that a Daniel's cell is, or a Grove or a Bunsen. If left short-circuited for any length of time through carelessness or accident, the owner may return to find his apparatus a wreck from which no current can be obtained. Used, however, through a high resistance, such as the human body, it retains its constancy for several hours, and even when finally weakened it regains its strength after a short interval of rest. With proper care it retains its vigor of action for many months, and in the case of the larger-sized cells for two years or more with very little attention. It is therefore for therapeutic purposes quite unapproached by most other forms of apparatus, and can confidently be recommended for the four qualities of constancy, strength, durability, and cleanliness.

Small Leclanché batteries for portable use have been constructed, but have failed to answer the purpose, for their very compactness has rendered them readily polarizable and easy to get out of order through secondary action. For portability combined with constancy the chloride-of-silver batteries can be highly commended. They are, however, costly, and another drawback is their extraordinarily high internal resistance, which necessitates a very much larger number of cells than other forms having only the same electro-motive force. As the Leclanché cell has an electro-motive force of one and a half volts, fifty of them would fully answer for every gynecological purpose.

The Gordon-Burnham battery is of the zinc and oxide of copper type, greatly improved, and develops a large amount of energy. The points of superiority as determined by careful tests and practical demonstrations are: Long life, discharging at a rate of 8 centiampères for six months without any attention. It operates equally as well on closed or open circuits.

By all means select large cells for office use. Holding a larger amount of material, they require charging less frequently and polarize

with less readiness. Added to this, they are cheaper in proportion to the work they do, and are far less liable to get out of order.

Mention should also be made of the Edison electric-light current. It is a current of low tension, not exceeding 125 to 200 volts, and is therefore devoid of danger; furthermore, as the internal resistance is slight, it can be used for the purpose of galvano-cauterizing as well as electrolysis. Arrangements are now perfected by which this current can be conveyed direct from the dynamo into one's office and utilized for all practical work. It is readily appreciated that with a current of such a considerable voltage some resistance should at all times be kept in the circuit.

2. *The Milliampèremeter.*—The milliampèremeter is to the physician using electricity what the scales are to the apothecary dispensing his drugs; and while this instrument of precision is by no means always essential in every electro-therapeutical application, it is safe to say that electrical treatment in gynecological cases could never have advanced as it has done had it not been for this great improvement in the method of electrical measurement. Mathematical precision has been substituted for the uncertain and generally inaccurate estimates of current-strength in internal applications, and the operator is now able to compare day by day the varying potentials employed, and to put in definite language instructions as to further treatment to whomsoever he may wish permanently or temporarily to confide the case.[1]

3. *The Rheostat.*—There are two principal ways of gradually increasing and decreasing the strength of the current without interruption, when the ordinary separate cells are used. The first and most common method being the ordinary current-selector attached to the element board of most stationary batteries. It is by no means the most certain or easy method, and in the majority of batteries as arranged it is impossible to manipulate these selectors without occasionally interrupting the current. It is therefore safer and more convenient to possess some form of water rheostat or some one of the various current-controllers in which the intercellular resistance is a solid instead of a fluid.

Of the water rheostats, the Bailey current-controller is perhaps as good as any. It is an improvement on the ordinary water tube-and-rod rheostat that has been in common use for so long a time in that it is possible to approximate more nearly the maximum meter-measurement that the whole number of cells employed is capable of giving. Instead of the rod, we have four broad carbon plates, which when immersed give a large surface contact, and which when lowered into or raised from the water increase or decrease the strength of the current through a very wide range of resistance.

[1] For further description of the milliampèremeter, see p. 78.

4. *Internal Electrodes.*—The electrodes for internal use should be of two kinds—for extra- and intra-uterine applications. For extra-uterine applications within the vagina the electrodes consist of a ball or disk of brass or carbon mounted upon a long insulated stem. In using the faradic current these electrodes are not necessarily covered by any protecting material. Applications of this current through the mucous membrane of the uterus or vagina cause no more sensation with uncovered than with covered electrodes. With the galvanic current, however, it is very different, and the matter of covering is of considerable importance. Ordinary absorbent cotton answers very well, and is much to be preferred to sponge; but the best protection to the mucous tissues is a carefully adjusted covering of sculptor's clay held in place by any light material, such as the lightest form of unbleached towelling or tarlatan. The carbon electrode is to be used in connection with the positive pole, and through both electrodes, when protected in this way, much stronger currents can be borne without injuring the tissues than if used without such covering.

As regards the intra-uterine electrode, an ordinary Sims sound can often be used with much satisfaction, provided the introduction is made in the Sims position. In the dorsal position the shaft or stem in contact with the vaginal walls should of course be insulated; otherwise a part of the current will be conducted away before the intra-uterine portion is reached.

No matter, however, what the method of application, insulation is to be preferred, and in the various forms of intra-uterine electrodes found at the instrument-maker's the uninsulated portion varies from half an inch to two or more inches, suitable for applications to the different parts of the endometrium in detail. When the positive electrode is used internally, it should of course be of platinum or some other material that equally resists the oxidation that takes place at this pole. It has of late been found that by subjecting steel to certain processes it can be rendered unoxidizable, and as the cost is much less than platinum, it becomes a desirable substitution.

Other sounds, uninsulated except by a movable sheath made either of hard rubber or glass, are preferably used by some, and while they enable one to extend or decrease the area of the uninsulated and active part of the electrode at will, there are certain disadvantages connected with them. It is impossible, in the first place, to extend the insulating sheath beyond the curve of the instrument, and they are more likely to remain unclean.

5. *External Electrodes.*—With every appliance complete and of the best—battery, internal electrodes, and instruments of precision—one will yet fall far short of accomplishing the best results in the treatment

of uterine disease without careful and correct attention to the character of the external or cutaneous electrode.

To Apostoli is due the credit of reducing to a system and practically applying the simple principle of physics familiar to all, that the larger the area the less the resistance. In all electro-therapeutical procedures the skin is the great obstacle to the efficiency of electrical action. With the ordinary sponge electrode, offering an immense resistance, it was not only impossible to obtain from any reasonable number of cells a current sufficiently strong to do effective work in many internal diseases, but the burning and pain under this external electrode readily became unbearable. The milliampèremeter, accurately registering the strength of the current, enabled us to appreciate the fact that it varied immensely according to the size and quality of the electrodes, even although the number of cells in the circuit remained the same. To overcome in the least painful manner this great cutaneous resistance Apostoli, as is well known, suggested electrodes of sculptor's clay.

Sculptor's clay is readily obtained almost anywhere, and with a little attention to detail each one can prepare these electrodes for himself and with but little expense. In the selection of the clay be careful that it is free from all admixture of sand, and combining with the utmost plasticity as little stickiness as possible. The character in this respect of the various kinds of clay varies considerably, and a poor selection may cause unnecessary discouragement. The clay should be soft, but not very soft. Its conducting power depends, of course, upon the amount of water absorbed. If the mass is too hard, there will be manifestly less readiness of conduction; if too soft, it becomes nasty and difficult to keep in place. It should be just plastic enough to be readily moulded to the inequalities of surface, and to impregnate every pore without dropping apart or spreading beyond the limits intended. If successfully made, so that the finger can penetrate it without effort, it can be moulded and used without any covering whatever. As generally used, however, it is enveloped by the thinnest kind of towelling, or, better still, by coarse tarlatan, through the meshes of which it can easily transude, and which, when the clay would be too soft to use without a covering, keeps it in compact form. A suggestion of Dr. A. Lapthorn Smith is that a little glycerin, through its affinity for moisture, will when added to the clay greatly aid in keeping it soft and pliable. When not in use it is necessary, in order to preserve the humidity of this electrode, to keep it covered with oiled silk or rubber cloth. When ready for use the mass should be of uniform thickness, neither too thick nor too thin. If the former, it will offer an unnecessary resistance and weight; and if the latter, there is the risk, in the slight spreading that inevitably occurs, of the metallic disk which covers the back of the mass of clay, and through which the electricity is con-

ducted to the clay, penetrating through the mass and coming in contact with the skin. These electrodes vary in size, according to the strength of current desired, from a few inches square to dimensions sufficient to cover nearly the entire abdomen.

6. *Operative Procedure.*—Intra-uterine galvano-cauterization, as well as the electrolysis of fibroids, require currents of some strength. Bearing in mind this fact, the necessity of careful deliberation in carrying out the details of these operations becomes sufficiently evident. In applications, whether extra- or intra-uterine, the dorsal position is generally sufficient, and is indeed to be greatly preferred. Sometimes, however, the difficulty of introducing the intra-uterine electrode is so great, and perhaps insurmountable, that the Sims position is found necessary—a position that is by no means so favorable for an easy and satisfactory adaptation of the cutaneous electrode as the dorsal. The abdomen is for many reasons the best position for this electrode, and, whether consisting of clay, of absorbent cotton, or other material, should be carefully adjusted and a few moments allowed for the skin to become thoroughly moistened before the introduction of the active electrode. Everything being in readiness, the current should be gradually increased, either by means of the current-selector or rheostat, until the milliampèremeter indicates the desired strength.

If the element-board is constructed properly, the current can be increased cell by cell with little if any danger of interruptions, and with the assurance that we are utilizing the total strength of the cells in the circuit. For absolute safety, however, the rheostat is to be preferred. The disadvantage of the water rheostats in common use is that, unlike the first method, we are unable to utilize the full strength of the cells in operation. This defect is in a measure overcome by the dry rheostat, several kinds of which are now obtainable.

Thorough antisepsis of both the hands and internal electrode is recommended. The current itself, however, is a good antiseptic, and experience shows that there is but little if any danger to be feared even if these thorough antiseptic measures are not adhered to. "The whole operative procedure," says Apostoli, "may be summed up in a good hysterometry, the operation itself being nothing more than a therapeutical passing of the sound where all traumatic action (except in the case of puncture) should disappear in order to give place to the highest degree of electro-chemical action. Manifestly, there can be no absolute standard as to the dose of electricity by any method or in any disease. Individuals vary immensely in their susceptibility, although the relative variation in the dose necessary to give, in the use of these intra-uterine electrodes or in the treatment of fibroids by puncture, is not so great as it is in external and purely non-surgical treatment. In the treatment of fibroids and in the galvano-chemical cauterization of the

endometrium when we desire the destructive action of the current in the treatment of granulations and fungoid growths, a certain amount of work has to be done, and this requires a definite strength of current. In beginning these intra-uterine applications thirty or forty milliampères are often sufficient, to be carefully increased according to the susceptibility of the patient, until 100, or even in some cases 150, milliampères are reached. It is in the chronic catarrhal diseases of the endometrium, as well as in later pathological conditions, when the uterine parenchyma becomes involved, that these intra-uterine applications of high tension are particularly applicable; and much well-authenticated experience clearly shows that in many instances it possesses advantages over caustics, the knife, or the curette. A most important advantage over caustics or the galvano-cautery is that its dose can be given with mathematical exactness, and according to the pole employed it is possible to obtain effects that are hæmostatic or congesting at will. Again, so gradually can we work up to the effect desired that the operation is devoid of those sudden and severe effects that are inevitably associated with other methods. While lesions of the uterine mucous membrane are amenable to the action of either pole according to the existing pathological condition—in the hæmorrhagic and profusely catarrhal forms the positive, and in others the negative pole—there finally, in many cases, comes a condition of the substance of the uterus which calls alone for the effects of the negative pole. These are the cases of chronic parenchymatous metritis which have baffled so often the best efforts of gynecologists by the old methods, but which bid fair to yield more readily to the new. In those cases of interstitial metritis which have reached the stage of induration some remedy that will act in a powerfully stimulating and derivative manner, that will excite the feeble and almost extinct circulation, hastening nutritive changes and quickening absorptive processes, is imperatively demanded." Such a remedy, says Apostoli, is found in "the negative pole, basic, diffluent, little or not at all hæmostatic, but, on the contrary, destined to excite the languid or perverted circulation and old, atrophic, or indurated forms of chronic metritis by a strong appeal to the intra-uterine circulation—the remedy, *par excellence*, for indurated chronic metritis, whether complicated with amenorrhœa or dysmenorrhœa; and it may be used with equal success in other inflammatory processes in which hæmorrhage does not predominate. The positive pole, acid, decongesting, hæmostatic in the highest degree, is especially useful in the hæmorrhagic, congestive, or ulcerative forms; it combats and prevents the tendency to excessive vascularization, and by the same process becomes an indirect treatment for rebellious leucorrhœa."

In the treatment of fibroid tumors even stronger currents are to be used than in the treatment of chronic metritis, and the same form of

external electrode employed to enable the localization at the active pole of these strong currents. Intensities as high as 250 and 300 milliampères are frequently used, and on one occasion at my clinic at the New York Post-Graduate Medical School and Hospital, abandoning the external electrode and introducing two needles connected with either pole, directly through the abdominal walls into the tumor, I applied for five minutes a current of 400 milliampères without ill effect. Both electro-puncture and intra-uterine applications are successful in reducing the size of fibroids.

When the tumor is intramural, intra-uterine applications are undoubtedly to be preferred to electro-puncture, but there are many cases where the fibroid is so situated that applications to the cavity of the uterus would have comparatively little effect, and the indications are for puncture. Deep puncture through the vaginal walls into the tumor is now considered by no means so necessary as formerly. The introduction of the uninsulated portion to the depth of a third of an inch only has, in my experience, answered every purpose, and is far less likely to be followed by bad results than deeper penetration.

For the absorption of pelvic exudations following cellulitis the galvanic current is invaluable. This treatment, persistently used, will dissipate pelvic deposits, and relieve severe sciatic pains due to the pressure of these exudations.

Stenosis of the cervical canal has been much relieved by galvanic treatment through the use of currents ranging from 40 to 75 milliampères. Using the negative pole, there seems to be little danger of any evil result, and the pain is quite slight.

Electricity in Obstetrics.

The use of electricity in midwifery is no new thing. As far back as the beginning of the present century it was recommended to hasten the expulsion of the fœtus, but it was not until a much later date that its use for this purpose excited any attention. "The indication for the use of electricity in midwifery is declared to be an adynamic condition of the uterus where other conditions are favorable for or necessitate immediate delivery."

There are many advocates of faradization in the last stages of delivery; and even in the first stage, when the labor has fairly begun, faradization of the lumbar region will sometimes hasten dilatation of the neck and excite the vigor of the uterine contractions. The current seems to have no ill effect on the fœtus, and indeed it is probable that but a small fraction of the current ever reaches the interior of the uterus.

There are very positive differences of opinion in regard to the value or necessity of faradization in hastening a confinement, but there should

be no differences of opinion in regard to the use of the current in cases of post-partum hæmorrhage. The old method of introducing one electrode of an induction apparatus into the uterus and applying the other over the abdomen was in many cases efficient, and has undoubtedly saved many lives by the promptness with which it induced uterine contractions. The efficiency and promptness, however, of this method are not nearly so great as the bi-polar method, where both poles are introduced into the uterus and the induced current of quantity employed. In the treatment of post-partum hæmorrhage it is of the greatest importance that the wide difference between the action of the currents of quantity and tension on the uterine tissues be thoroughly appreciated. The current of tension when applied externally produces most vigorous muscular contractions, but when applied internally its effects are modified in a most remarkable degree. If the uni-polar method is used, the external electrode will still produce strong contractions, while the internal electrode is hardly felt. Using the same current with both poles applied internally, the contractions that are produced are comparatively slight and inefficient, and in a dilated and inert condition of the uterus it is entirely probable that it would exert not the slightest effect. The current of quantity, however, which when applied externally possesses but little appreciable effect, acts with extraordinary vigor when applied internally to the uterus or vagina. One who is accustomed only to external applications, or who has given no attention to this most interesting electro-physiological and therapeutical phenomenon, would very naturally, if suddenly called upon to treat a case of post-partum hæmorrhage, use the current of tension, which ordinary experience has shown to be so much stronger than the other. In doing this, however, he would be likely, if there existed a marked adynamic condition of the uterus, to utterly fail in inducing any adequate muscular contractions, and fatal hæmorrhage ensue with a remedy at hand capable of successfully combating it.

Electricity has occasionally been successfully used to increase a deficient lacteal secretion. Both the galvanic and faradic currents have been used with apparent effect, but the faradic current, on account of its greater mechanical effect, is perhaps to be preferred. In using electricity, however, for this purpose it should be borne in mind that overstimulation may do positive harm in dissipating the slight secretion of milk that may still be present.

Electricity has been used with great success in extra-uterine pregnancy.

While there exists much diversity of opinion as to the value of the method in this condition, some even going so far as to condemn it *in toto*, the very important and suggestive fact should not be forgotten that those who thus condemn it are, as a rule, of the number who have

had no adequate personal experience in the matter. From the standpoint of the writer, who has personally treated by electricity as many if not more cases of ectopic gestation than any other, the method clearly seems to be the best, and the only one that should be attempted in the earlier stages.

As early as 1872 electricity was successfully used in these cases for the destruction of the fœtal life, but it was not until 1878 that the details of the method excited any general interest in the profession or incited others to make similar attempts. In that year a case occurred in the practice of Dr. Charles McBurney of New York, and in a consultation with Drs. T. Gaillard Thomas and T. Addis Emmet, Dr. Thomas suggested the possibility of the use of electricity instead of the knife. When questioned as to the possibility of the operation, I replied that the destruction of the fœtal life was an easy matter, and that it could probably be readily accomplished without special pain or injury to the mother. The results of the attempt, immediately made, fully justified this prediction, and there soon followed many reports of similar cases equally satisfactory. The operation is simplicity itself: One electrode is applied internally, pressed as closely as possible against the fœtal mass, while the other is applied on the abdomen immediately over it. Both currents have been successfully used. If the faradic current is attempted, either pole may be used internally, although the negative is to be preferred. The negative pole is also to be preferred in the use of the galvanic current for this purpose, and is the current which in my opinion performs the work required of it with the greatest certainty and efficiency. An interrupted rather than a continuous current is to be employed, although there may be an advantage in its rapid increase by means of a rheostat. In this way the chemical and physiological effects can be greatly increased, without the disagreeable effects, and even the danger, that might accompany an interruption of the same strength of current. In cases that are somewhat far advanced the danger to be apprehended from an injudicious application of the faradic or the interrupted galvanic current is the possibility of rupturing the over-distended tube. In one case, where the pregnancy had advanced nearly to the fourth month, the necessity for caution forcibly presented itself to me. By gradually increasing and as gradually decreasing the strength of the current I was enabled without fear to make use of a much stronger current than if interruptions had been made, and in this way succeeded in destroying the fœtal life. In regard to the position of the poles, my custom has been to place the positive pole externally. This should consist of a broad, flat sponge pressed firmly on the skin and directly over that portion of the tube where the fœtus is developing. The negative pole is used internally, and may be carried up to the fœtal mass through either the vagina or rectum, according to the posi-

tion and size of the tumor. In fifteen cases that I have recorded the operation was performed through the vagina in twelve and the rectum in three.

As there seems to be no way of determining positively whether the fœtal life is immediately destroyed by the first application, it has been my custom to repeat it three or four times; and as but little pain is caused, there can be no objection to its repetition on this score. All medical and surgical procedures, however, that are not absoluetly necessary are objectionable, and a remote possibility even of an accident of the kind to which reference has been made—viz. rupture of the tube—suggests that these applications be made no more frequently than will suffice to accomplish our object. It is proper to say, therefore, that a strength of current just sufficient to destroy the fœtal life is, in all probability, capable of doing it at once, and that all subsequent efforts serve only the purpose of hastening the process of absorption. Applications that are made for this purpose alone cannot be at all objectionable, as the uninterrupted galvanic current is the form indicated. Even to this day there are many who suppose that the operation is purely electrolytic, necessitating the introduction of a needle into the fœtal nest. Happily, such is not the case, for any such procedure might itself be attended with danger, and certainly with considerable pain. The negative electrode consists of a metal ball, and is applied *to* and not *into* the tumor.

Cataphoresis.

By cataphoresis we understand a property of the galvanic current entirely physical and in no sense electrolytic. The absorption of medicated solutions and the production of anæsthesia by means of cataphoresis has become firmly established as a fact of considerable scientific value. The method of producing anodal diffusion, as it is sometimes called, is very simple. The solution to be absorbed is dropped upon the positive electrode, which is applied directly to the diseased part, while the other electrode is applied to any indifferent portion of the body. Platinum or gold, being absolutely non-oxidizable, are preferable as electrodes for the positive pole, but these are expensive, and therefore blocked tin, which is practically non-oxidizable by weak currents, may be used, and answers every purpose. The dose should be accurately measured. This can readily be done by fitting absorbent cotton or tissue-paper to the non-oxidizable electrode, and dropping upon it in measured doses the cocaine, strychnine, atrophine, or such other solution that it is desired to utilize. The strength of the current depends on the size of the electrode and the effect desired. From 2 to 20 milliampères may be used, although when the applications are made to sensitive parts, as in dentistry, a

fraction of a milliampère may be sufficient. The greatest utility of cataphoresis is found in maladies of the skin and mucous membranes, or of immediately subjacent tissues. In persistent sub-orbital neuralgia cocaine cataphoresis often gives relief for from four to ten hours, but does not cure neuralgias of peripheral origin. Chloroform causes dermatitis, and should be used only when counter-irritation is desired in conjunction with transitory anæsthesia. Helleborin and aconitine have also been used successfully, but the latter, while it gives rise to analgesia, also causes painful smartings and burnings, unless combined with a cocaine solution. In its application it is sometimes useful to prepare the skin a little before treatment by rubbing it with ether to dissolve the oil globules. There can be no doubt that the effects of the galvanic current upon nutrition are in part due to the cataphoric transfer of molecules of protoplasm and liquid from one cell to another, or from a cell to a capillary vessel in the path of the anodal stream; and since the diffusion takes place more readily and more quickly in direct proportion to the current-strength, it behooves us to employ as many milliampères as feasible in our galvanization of the atrophied and paralyzed extremities of poliomyelitis, chronic neuritis, and peripheral nerve trauma.[1]

Interstitial or Metallic Electrolysis.

This method of treatment is applied more especially to mucous membranes, and finds its greatest field of usefulness in uterine disease. It was first described and systematized by Gautier.[2] In its practical application, some metal electrode, mainly copper or zinc, is applied to the diseased part, and the chemic action of the positive pole is utilized, not only for its effect upon the tissue itself, but upon the metallic electrode. If zinc is used, oxychloride of zinc is formed and deposited in the tissues, and if copper, oxychloride of copper. Cataphoresis is the product of electrolytic action, and it is this cataphoric property of the current which carries or forces these salts through the surrounding tissues to a greater or less depth, according to the strength of the current and length of treatment. As compared with the ordinary method of galvano-cauterization the experiments of Gautier on rabbits seemed to show that interstitial or metallic electrolysis with copper electrodes was the more efficient method in its microbicidal action. The technique of this treatment is similar to that of the galvano-caustic treatment of the uterine organs, only it is to be remembered that while in the last method either pole may be indica-

[1] *Annual of the Universal Medical Sciences*, vol. v., 1894.

[2] "Technique d'Electrothérapie," *Revue Internationale d'Electrothérapie*, July, 1893.

ted, in metallic electrolysis, as in cataphoresis, the positive is always the active pole.

Electrolysis.

Electrolysis is more especially a surgical procedure, and, strictly speaking, perhaps has no place in a work of this character. Every passage of a galvanic current, however, through any compound substance is undoubtedly accompanied by some chemical or electrolytic change, although manifestly very slight in degree.

When the electrodes of a galvanic battery are immersed in water and the circuit closed, a more or less abundant evolution of gas takes place. Oxygen appears at the positive pole or anode, and hydrogen at the negative pole or cathode, and the water is separated into its constituent elements. This is termed "electrolysis," the act of decomposing a compound substance by electricity. If a salt solution is subjected to the action of the current, the process is similar, but more complex, the acid being set free at the positive and the alkali at the negative pole. The accepted theory of electrolysis is in harmony with the statement just made, that the passage of a current through the body is associated in every part of its course with more or less chemical action. In every compound one of the elements is electro-positive and the other electro-negative. Under the influence of the opposing electricities from the electrodes decompositions and recompositions go on from one pole to the other. But these decompositions and recompositions are seen only at the electrodes. Water is composed of one atom of oxygen and two atoms of hydrogen. Oxygen is electro-negative, and hydrogen is electro-positive. When, now, the electrodes are dipped in water, the electro-negative oxygen of a molecule of water is attracted to the positive pole, and the electro-positive hydrogen is repelled. The oxygen is then given off at the positive pole, while the liberated hydrogen unites itself with the next atom of oxygen, and the original atom of hydrogen is expelled. This atom of hydrogen unites with the oxygen of the next molecule, drives out the hydrogen with which that alone has been previously combined, and so on through the whole series of molecules until the negative pole is reached. Here the hydrogen has no more oxygen to combine with it and is liberated as gas. Thus, while the decomposed elements appear only at the electrodes, the intermediate regions presenting no change, it is necessarily traversed by the decompositions that occur.

There is no evidence that organization as such seriously modifies electro-chemical decomposition. The fluids of the body decompose under the influence of the current, just as the same combination of fluids with tissue would decompose if not endowed with life. The great difference, however, in the effects of electrolysis on organic and

inorganic substances is seen after the current has ceased to act. In the electrolysis of most inorganic substances—such, for example, as iodide of potassium, acetate of lead, chloride of sodium, etc.—the effects cease as soon as the current ceases; the substances remain in the condition that the current left them. The electrolysis of organic substances starts a process that continues long after the current ceases to flow.

It is to this secondary effect of the current that we must ascribe the gradual but complete disappearance of some small tumors following one or more electrolytic operations. A young woman aged twenty-two came to me some years ago with a goitre of considerable size that had been developing since the age of sixteen years. Electrolysis was used only four times in this case, and at intervals of a week. An appreciable reduction of size was evident, after which the patient came no more. The tumor, however, continued to decrease, and when I saw her, a year subsequently, had entirely disappeared. Such results are rare, but it is not very unusual to witness some further reduction of goitres, and even fibroids, after the cessation of treatment.

Nothing can be more satisfactory than the readiness with which erectile tumors are cured by the introduction of one or more insulated needles and a judicious management of the chemical or electrolytic action of the current.

Reference is not made here to the widespread dilatation of cutaneous vessels, attended with little swelling, commonly called mother's mark, but rather to the subcutaneous variety called aneurism by anastomosis, which may be either venous or arterial. The great advantage possessed by electrolysis is that it cures, provided that the conditions of success be skilfully observed, without hæmorrhage and with little or no scar. When the tumors are situated on parts hidden by the clothing this is not always considered of such great consequence, but when situated on the face, as is so often the case, it is of vital importance. The needles must have a perfect insulation up to within a distance from the point varying from a few lines to a quarter of an inch, so that the skin may be thoroughly protected.

We must do just enough, without doing too much. If the current is too strong or the application too prolonged, the destruction may be greater than is required, followed by a discharge of pus; and this may result in cicatrization. If the current is too weak and the treatment too short, the tumor may re-establish itself, necessitating a repetition of the operation. It is not claimed that all nævi can be cured without a scar, but many can be; and in the large ones, where the chemical effects of the current extend to the skin, the patient, if a child, rapidly outgrows them. Both poles may be used, connected with the needles, but my experience in a large number of cases is in

favor of only one pole in the tumor, the other being applied externally on some indifferent point by means of a sponge electrode. The needle should by preference be connected with the positive pole, since the coagulation at this pole is more rapid and firmer than at the other. If the tumor is small one needle may be sufficient, but if large, needles may be connected with both poles.

HYDROTHERAPY.

By SIMON BARUCH, M. D.

HYDROTHERAPY.

Hydrotherapy is a term derived from *ὕδωρ*, "water," and *θεραπεια*, "treatment," which may be applied to the methodical application of water for remedial purposes, either hygienic or therapeutic. The term has been erroneously applied to the external application and drinking of cold water alone. This is probably due to the popular use of the word *water-cure* adopted by the empirics calling themselves hydropaths, who originally confined their practice to water of low temperature.

Guided by the correct derivation of the term, this article proposes to discuss the therapeutic uses of water in all its forms, from the lowest temperature to the highest, including its application *within* the cavities of the body as well as upon the surface.

Baths for Hygienic Purposes.

Among the agencies which the experience of the human race in all ages has demonstrated as conducing to the preservation of health and the prolongation of life, personal cleanliness takes the most prominent position. Physiology confirms the correctness of this popular idea. The enormous surface of the skin, supplied as it is by all the nervous and vascular accessories which make it a vast gland, causes it to be one of the chief, if not the foremost, depurative organs of the body. Hence its proper discipline becomes a valuable preservative of health, since many diseases are traceable to the influence of temperature-changes upon the skin.

The application of baths for hygienic purposes begins with infancy, when the sensitive condition of the skin demands a careful adaptation of temperature. The daily warm bath, from 90° to 100°, has become a practice among the better educated people for children. Unfortunately, the practice is discontinued too frequently later in life. The advantage of cleanliness as an element of hygiene need not here be dwelt upon. But the value of bathing in lower temperatures for the purpose of maintaining the reactive power of the skin cannot be too emphatically insisted upon, because experience has demonstrated its

effect in protecting the system, commonly termed the "hardening effect." For this purpose a daily rapid contact of the body with water of sufficiently low temperature to produce a shock, which is followed by reaction, is required. That the physician should insist upon not only the frequent systematic cleansing of the body with warm water and soap, which soften the epidermis and remove accumulated secretions, is a trite and oft-repeated idea. But that he should instruct those under his care, especially when young, to accustom the skin to rapid temperature-changes by systematic cold ablutions, followed by exercise, is not regarded as imperative unless some ailment brings the subject to his notice. Upon this point, therefore, instruction should be given to the medical student, in order that his future *clientèle* may receive full benefit from this modern use of cold water and exercise for purposes of hardening the system and enhancing its resistance to fatigue and disease-producing influences.

The mode of life of the present generation, which differs from that of more primitive times by intensifying the nervous energies and enhancing the desire for stimulating food, drink, and occupation, which conduce to a diminution rather than an increase of physical vigor, demands the introduction and popularization of some method of counteracting these influences. Weak constitutions, manifested by anæmia and muscular inadequacy, have been notoriously improved by climatic influences and outdoor life. If to these were added that methodical daily contraction and subsequent dilatation of the peripheral blood-vessels resulting from a brief cold plunge or sponging, these vessels could be endowed with the same tone and vigor which gymnastic exercise confers upon the voluntary muscles. This is the essence of the "hardening process," as it furnishes the means of improving the functions of the body which depend upon the integrity of the neuro-vascular supply of the skin.

Aside from this effect, this neuro-vascular discipline protects the system, as has been stated above, against those deleterious temperature-influences termed "colds." The exact *modus operandi* of the factors involved in this common process is unknown—whether it be neuropathic, by irritating the terminal sensory nerve-endings, and thus producing reflex vaso-motor and trophic disturbances in the mucous membranes or in the internal viscera, or by chemical changes in the blood, as Senator claims in rheumatism, or, as Winternitz perhaps more correctly surmises, by retention of products of tissue-change. That the thermic impression is most frequently upon the periphery of the body daily experience testifies when we are exposed to a draft of cold air; that it is probably a reflex from the peripheral nerves to the vaso-motor nerves within the body, the rapidity of the effect would confirm. Hence, the training of the peripheral nerves to bear these irritants without

resentment would afford protection against them. A diminution of irritability is thus induced by the daily peripheral neuro-vascular exercise caused by cold bathing, which results in "hardening." The most useful method is the gradual accustoming of the body to the shock from cold water, which is always followed by reaction if the temperature be correctly chosen. To ensure care it has been the author's habit to advise standing in twelve inches of water at 100° F., and resorting to a rapid sponge-bath of 80° F. This is reduced daily two degrees, until a temperature is reached below 50° F. When this has been done a few days, a daily plunge into water at 80° F. is advised, the temperature of which is reduced in the same manner until 50° F. or lower is followed by an agreeable reaction. This is manifested by a pleasant warmth and absence of prolonged coldness of the feet and hands. This bath should be taken in a room having a temperature of not less than 65° F., and ample provision for the rapid execution of the bath and the subsequent drying of the surface should be made. Such a bath has served as a preservative of health and strength in feeble individuals with a tendency to disease, especially in anæmic literary and professional people and in persons who lead a sedentary life or who are subjected to great mental strain in the pursuit of their avocations. Unfortunately, the facilities for such baths are open to but a small portion of the community in cities and towns. But even the humblest dweller in the rural districts may contrive a simple cold sponge-bath if he can be made to understand its value as a preserver of health and a promoter of longevity. The poor in our cities, however, crowded into tenement-houses in which one faucet usually supplies an entire floor, are debarred from this wholesome hygienic measure because of lack of room. Physicians frequently observe how the filthy condition of our poor is responsible for the spread of many diseases. The so-called "tenement-house odor," which so often offends in crowded street-cars or halls, is nothing more than the decomposed sebaceous secretions which have accumulated in unventilated clothing. The modern sanitarian recognizes that in purifying our habitations and our persons lies the great prophylactic.

Public Baths.—Public baths for the poor are becoming more and more clearly recognized in modern times since the first one was established in 1842 in Liverpool. The English Parliament took an active interest in the matter, and encouraged their establishment in the United Kingdom by its wise enactments; and France and Belgium soon followed this example. But Vienna led the world in establishing the ideal baths for the poor in the Volksbad in the Mondscheingasse, which many other German cities have imitated. In his report as chairman of the Committee on Hygiene for 1890 of the New York

County Medical Society the writer suggested the erection of similar baths, insisting that the following points be observed:

1st. The baths must be located in the very centre of the crowded districts.

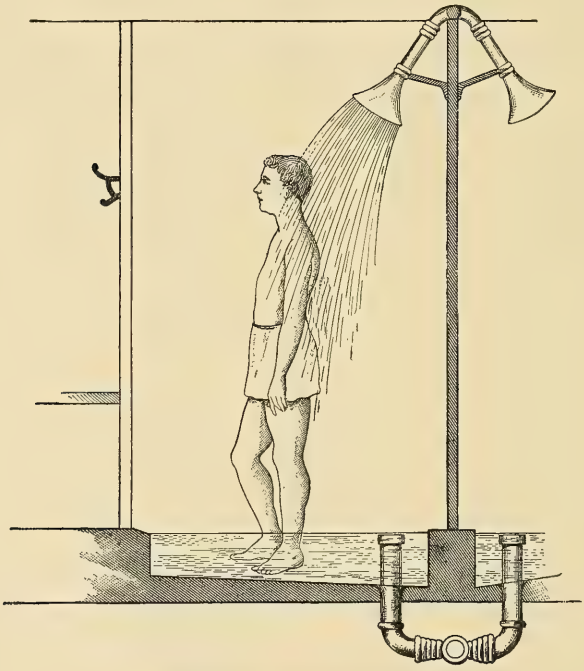
2d. Their exterior must be modest.

3d. They should be so constructed that a thorough cleansing bath may be obtained without trouble or expense and without sacrifice of much time.

These conditions may be fulfilled only by the abolition of the bath-tub and the substitution of the warm rain, or shower-bath for the old-fashioned tub-bath. The advantages of such a bath, falling upon the body with considerable force from a reservoir of some height, are self-evident. By this means—

(1) The outlay for tubs is avoided, as well as the cost of the wear and tear.

Fig. 68.



Compartment for Public Baths.

(2) The avoidance of filling, emptying, and scrubbing of the tub, for each bath economizes labor and expense.

(3) The time needed for a cleansing bath is far less, and the cleansing more thorough, because the patient does not bathe in water already soiled.

(4) The space required is one-half.

(5) The water required is about one-tenth.

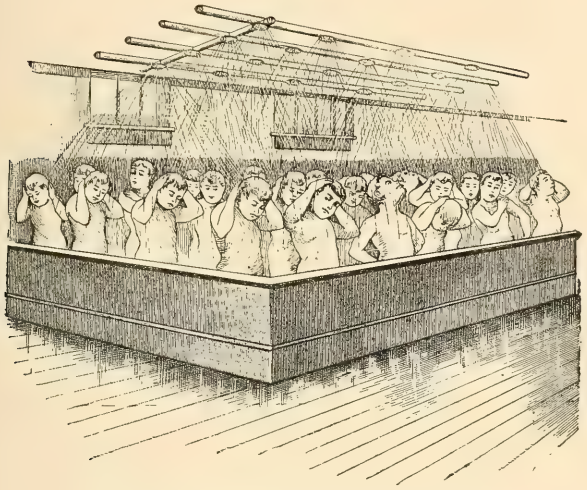
(6) The danger of communicating disease is removed.

(7) The refreshing effect of a cold shower after a warm bath may be secured.

The bather simply steps upon the inclined asphalt floor, opens the valve, and allows the coarse stream of warm water to descend upon him, while he soaps and rubs himself. The soiled water runs off, and the next bather may at once enter.

For public institutions, where large numbers require bathing, the economy and practical value of these rain-baths will be a great boon.

FIG. 69.



Author's Bath at the New York Juvenile Asylum.

The bathing-pool needs only to be mentioned to elicit condemnation. The herding of a number of individuals in prisons or other institutions not only offends the æsthetic sense, but must conduce to the spread of disease. I have introduced rain baths into the New York Juvenile Asylum. The arrangement of pipes near the ceiling is provided with sixty-eight convex sprinklers, $2\frac{1}{2}$ inches in diameter, 20 inches apart, throwing a stream which widens to 20 inches, and is placed over the tiled slanting floor of the bath-room. By mixture with steam the water is heated to the proper temperature. Two hundred and eighty-one children are bathed each hour, while by the plunge-bath only eighty could be bathed in the same space. The consumption of water is reduced to one-eighth by exact measurement.

The Association for Improving the Condition of the Poor in

New York City was the first to erect a public bath and adopt the rain-bath for institutional use. The building in Centre Market Place consists of two stories of brick, occupying a space of 61 by 27 feet. It has facilities for bathing 1000 people each day, and actually bathed many thousand persons last year (1899).

The Riverside Association, 259 West Sixty-ninth Street, which devotes only the basement of the building, 68 by 25 feet, to baths, has given 155,000 baths during the past four years.

The Public Bath and Wash House in Gaskill Street, Philadelphia, which is also constructed on the plan advocated by the author in 1890, has twenty-six bathing compartments, accommodating 900 bathers daily.

The Public Baths of Chicago, introduced by Dr. Gertrude Gail Wellington after visiting the New York baths and receiving the author's views, bathed 301,468 persons in 1899. There are two baths in course of rapid construction in Chicago.

But the greatest advance in this direction has been made by the writer's success in obtaining in 1895 the passage of a law by the New York Legislature, making mandatory provision for free public baths of hot and cold water for all cities exceeding 50,000 inhabitants. In obedience to this act the city of Buffalo constructed such a bath in 1897, which in the succeeding two years bathed 155,354 persons without any charge. New York City is also building a free public bath on Rivington Street, which will accommodate one million bathers annually. The establishment of the rain-bath will now solve the public bath question, because it is complete, economical, and practical. If it be the function of public authorities to furnish parks and breathing-places for crowded cities, especially in the tenement districts—as has been recognized by recent legal enactment—it is equally the duty and functions of the city authorities to furnish free opportunity to the tenement population for keeping their persons clean. The former cleanse within, the latter without the body—if we may be allowed a physiological simile.

Hydrotherapy in Disease.

The therapeutic value of water is established by the most convincing evidence, obtained at the bedside in all countries and in all epochs of the history of medicine. While other remedies which have been heralded as prolific of good have been cast into everlasting oblivion, or have from time to time enjoyed a more prolonged reputation, water is the only remedy which has stood the test of time since Hippocrates furnished medical literature with the first treatise on the subject. Bloodletting, which from the earliest dawn of medicine rallied the best minds to its support, and for some time towered above all other methods of

treatment and resisted the onslaughts of its few yet able opponents, lost its foothold so soon as the light of modern research exposed the fallacious reasoning upon which it is based. Water, on the other hand, whose paternity is coeval with this once universal remedy, but which never approached the same complete dominance, is to-day more highly esteemed than ever by some of the best clinical observers. The more fiercely the light of modern research beams upon it, the more glaring become its points of vantage, because its application is based upon well-recognized physiological principles. The verdict of history is pronounced in favor of water as a valuable (but not universal, as the hydropaths would make it) remedy. That in all epochs the most brilliant minds advocated its use most earnestly a brief reference to history will demonstrate. Hippocrates devoted one of his books to the discussion of water as a remedy. His acute observations demonstrate the principles of hydrotherapy in an empirical but correct manner. He discovered the stimulating or warming effect of cold water and the soothing effect of warm water, and utilized the former in syncope and the latter in insomnia; he discovered the diuretic effect of the cold bath in fever, and even insists that it is more useful in inflammation of the lungs than in ordinary fevers, because it renders the expectoration more fluid and relieves dyspnœa and pain in the side. Asclepiades of Prusa, whose brilliant accomplishments made him the intimate of Cicero, and who was the founder of the school which furnished men like Themison, Antonius Musa, and Celsus, was an ardent advocate of water as a remedy. In his *De re Medica*, third book, Celsus recommends cold ablutions and the cold bath in fevers, and insists upon their early application. Galen too, frequently advises the use of cold water, and the use of cold affusions to the head while the patient sits in warm water—a method to-day resorted to in the collapse, coma, or in the somnolence of fevers—originated with him. In his seventeenth book the directions for treating fevers by cold are marvellously clear; they could be literally transcribed and utilized to-day. His theory of hyperpyrexia and its treatment is in accord with that now accepted. He says the only cure of fevers is by abstraction of heat after the cause is removed.

A great cyclopædia of the medical sciences, published by Oribasius in A. D. 360, contained a chapter on "Febris Exacerbatio balneis naturalibus curata."

Rhazes ordered in measles that "as soon as dyspnœa becomes very great a cold bath must be given, and the body must be well rubbed until the eruption appears." We cannot improve upon these suggestions at the present time.

That the use of water was popular among the Arabian physicians

is testified by Prosper Alpinus, who visited Egypt in 1580, and observed that "the people take a lukewarm bath for refreshment, often dipping themselves afterward in cold water; not only the well, but those sick with fever, do this." Thus had the doctrines of the Alexandrian School, which utilized baths and cold drink in fevers, been transplanted into Egypt and endured a long time.

In the seventeenth century we find the great Dutch physician Herman Vander Heyden a warm advocate of water in disease. His 363 cases of malignant dysentery recovering under hydrotherapy are among the most brilliant achievements in clinical medicine. Van Helmont also used water extensively.

England has contributed probably as much as any other country to the dissemination of hydrotherapy. Floyer's *Inquiry into the Right Uses of Hot, Cold, and Temperate Baths*, published in 1697, is a classic which has been translated into all modern tongues. The practice of hydrotherapy was warmly adopted by Baynard, Blair, Brown, Pitcairn, Cheyne, Huxham, and other eminent practitioners, chiefly in acute diseases.

Floyer's learned treatise made such an impression upon Friedrich Hoffman that the latter taught this doctrine and practice from his university chair, basing the action of cold water chiefly upon the effects upon the tone of the blood-vessels. Thus was it disseminated among educated physicians in Germany. Later, such men as Van Swieten and the Hahns, father and son, espoused hydrotherapy as a part of their practice in acute and chronic diseases, especially in the exanthematous fevers.

The exploits of Wright and Currie, which were published in the last years of the eighteenth century, are to English and American physicians the most familiar historical facts connected with hydrotherapy. How correctly Currie estimated its rationale in typhus and low forms of scarlatina is evident from the following passage: "We are not here to await the good offices of Nature and assist her supposed efforts, but to combat the fever in all its stages with our best powers;" and he used cold sea-water, 37° F., because of its greater irritating effect, which produces reaction. A proof of the proselyting influence of the work is cited by Pollak, to whom I am indebted for many historical data. Franck, who was an enthusiastic apostle and studied under Currie, introduced his methods into the Viennese Hospital, where they have since held almost constant sway under men like Hirschel, Froehlich, Mauthier, Plith, Plennger, Dumreicher, Friedman, Rosenthal, and, last and far from least, the father of scientific hydrotherapy, Wilhelm Winternitz.

Despite this original and earnest advocacy of the remedial value of water by English physicians, the latter are to-day among its least

active employers. In the London hospitals one rarely hears the cold bath advocated, even for typhoid fever. Floyer and Currie, who converted eminent physicians in the entire world to their doctrines, failed to impress their own colleagues with its value.

The eminent Italian physician Joseph Giannini says: "Humanity owes Currie a debt of gratitude for having brought to a correct light so excellent a procedure, and having so bravely taken up the battle against prejudices." This practitioner discovered the value of full baths, which he advised night and day when required by high fever, and thus laid the foundation of the great triumph of the Brand treatment of to-day.

As one name among many illustrious advocates of hydrotherapy in Germany must be remembered Hufeland the philosophical physician, who was so deeply interested in the subject that he offered a prize of fifty ducats for the best essay, which was carried away by Froehlich, the Austrian court-physician, who demonstrated his great confidence in hydrotherapy by insisting that it was capable of shortening typhus if used in the very inception of the disease.

During the past forty years, which may be regarded as the most eventful epoch of medical history—a period during which the doctrines of schools were displaced by the exactness with which instruments of precision invested diagnosis, by the light thrown upon disease by pathological and microscopical study, and by the great discoveries in electricity for diagnosis (*x*-rays), and the advances in chemistry, which promise so much for treatment—water has risen to a higher status than ever before. In every country where medicine is cultivated assiduously there are men of acknowledged ability as clinical observers who are not only warm but energetic advocates of hydrotherapy. Semmola and Cantani in Italy, Liebermeister, Ziemssen, and Strümpell in Germany, Dujardin-Beaumetz and Glenard in France, Delafield, Peabody, and Osler in America—these are names which stand as vouchers for any therapeutic method, and bid us carefully scrutinize it ere we are moved by prejudice to reject it.

While the modern practitioner happily owes allegiance to no school and is not under the thraldom of any authority, let him not disregard the clinical results, based upon rational principles, which are recorded on the subject of hydrotherapy.

To bring the American physician more *en rapport* with the justly eminent advocates of this method is the aim of this article.

Rationale of the Action of Water.

No remedial agent is worthy of the serious attention of the physician if its action has not been rationally studied. The action of water as a remedial agent may be explained upon strict physical and

physiological principles. Its effect upon the body is traceable—first, to mechanical impact; second, to temperature effects. These effects are modified in accordance with the part to which the application is made, the condition of the individual, and his environment. As an illustration may be mentioned the varying effect of an application of melting ice to the toes in a healthy individual while awake or asleep, drunk or sober. The mechanical impact produced by friction of the water from a douche—which is a stream propelled with force by two or more atmospheres—will produce the stimulating effect of massage of the part, while water of the same temperature applied by a sponge would produce only a chilling effect.

Tuerck has shown that anæsthesia of the skin may be removed by gentle rubbing, and that friction or pressure acts upon the peripheral circulation is constantly observed. Stroking the skin with the fingers leaves pale lines, resulting from the driving of blood from the superficial vessels, which, however, immediately disappear and return as a red line. This effect produced by mechanical impact upon the peripheral vaso-motor nerves, both stimulating and relaxing them, is conveyed to the central nervous system, which responds by effects upon the respiration, the cardiac movement, the distribution of the blood, and the vascular tension. Thus the local disturbance of the circulation by mechanical impact of fluids becomes an important factor in hydrotherapy, to which reference will be made later.

Second, the temperature effect produced by water is really the chief element in its therapeutic application. To realize fully the importance of this proposition reference need only be had to the anatomy and physiology of the skin as it is revealed by modern researches. Briefly and simply told, the skin presents not only the most extensive continuous vascular and nervous area of the body, but it is the most accessible surface to all external impressions. Herein may be sought the relation and importance of the skin to all the systemic functions. The large cutaneous surface stands guard, as it were, over the entire body. Being a sensory organ, it receives all impressions of irritants, be they thermic, mechanical, chemical, or electrical, which may combine all.

Thermic irritants, heat and cold, are the chief elements in all hydriatic procedures. They make impressions upon the terminal nerve-endings which abound upon the cutaneous surface. The sensory impressions act in a twofold manner: First, they are conveyed to the central nervous system, whence reflexes are emitted which have the most important bearings upon all the functions of the body. Second, the effect upon the vaso-motor nerves produces a narrowing of the surface vessels, which increases the resistence to the circulatory current and thus raises the blood-pressure. This constriction is followed, in accordance with familiar physiological laws, by relaxation;

and this effect depends, in turn, upon the extent and intensity of the irritation.

These simple and briefly-stated physiological facts furnish an explanation of the seemingly paradoxical effects of hydriatic procedures. They also furnish the key to the remarkable yet positive effects which the latter are capable of producing upon the respiration, circulation, tissue-metabolism, secretion, and temperature-changes of the human organism.

Effect of Peripheral Irritation upon the Respiration.—At the very dawn of life we are forcibly reminded of the influence of cutaneous irritants upon the respiration. The first inspiration is due partly, if not chiefly, to the impact of colder air upon the surface of the infant; and a most reliable measure for the establishment of retarded inspiration, and for its maintenance when feeble, is the dashing of cold water upon the cutaneous surfaces, and, that failing, the rapid variation of hot and cold impressions (by dipping in warm and cold water) upon it. The familiar example presented by the ordinary treatment of syncope, by dashing cold water upon the exposed body, is another illustration of the powerful influence of thermic irritants upon the respiratory innervation. That heat produces the same effect as cold has recently been the experience of the writer. After an operation for an abscess an extremely sensitive male patient swooned away, presenting tonic contraction of the muscles and complete cessation of respiration and pulse. Dashing an entire basin of cold water (about 65°) upon the face produced not the slightest effect. A pitcher of hot water being convenient, I poured about an ounce on one leg which was hanging lifeless over the edge of the bed. The patient at once was aroused to consciousness, but he suffered from a burn for several days.

The first effect of cold upon the terminal nerve-endings with which we shall have chiefly to deal in this article is the conveyance of the irritant impulse to the respiratory centres, producing a gasping respiration, which gradually deepens and becomes more rapid. It is difficult to separate the effect upon the respiration from that upon the circulation. The proportion which exists between the number of pulsations and respirations is usually changed by the application of cold. Deep inspiration must facilitate the general circulation, while it offers a certain resistance to the internal circulation. Complete expirations have the opposite effect. Whatever influence, therefore, is brought to bear upon respiration must to a greater or less degree affect the circulation also. The deepening of the inspiration by cold upon the surface, if not excessive, is so well established by daily observation that it requires only this brief reference. Even the empirics have recognized this fact, inasmuch as they invariably order the patient to go into the open air after most hydriatic procedures. The deepened involuntary inspira-

tions enable the patient to obtain a large supply of oxygen, which, after all, is the chief life-giving element in nature, and when abundantly but not artificially supplied to the lungs excels all medicinal tonics in restoring the functions to a vigorous norm.

Effect of Peripheral Irritation upon the Circulation.—This effect is local and general. The first result of a local application of cold or of extreme heat is contraction of all the muscular tissues coming in contact with it. Hence the muscular fibres of the skin, as well as the circular fibres of the cutaneous vessels, are contracted, with the result that the latter are emptied, as is evidenced by the pallor and shrivelled condition assumed by the skin. In this way we have the washerwoman's hand from heat and the cutis anserina from cold. At this point comes into play the physiological action of all organic muscular fibres. The latter respond slowly to stimuli and recover from this action with equal tardiness. Still, even this effect may be modified by the intensity and duration of the application. The more intense the latter, the more rapidly will the vessels contract and become anæmic. A brief application will result in rapid reaction, while if the application be continued reaction will be interfered with; paralysis of the vaso-constrictors will result from over-stimulation; the vessels will dilate; the skin will become red, and lastly, cyanotic. The vitality of the part may thus be reduced, when anæsthesia results, and if the cold be continued destruction of the part ensues.

Thus we may induce in the circulation innervation and nutrition of the part by the simple application of cold to any portion of the periphery, a powerful change either for good or for evil. The immense latitude of effect between the application of moderate and extreme cold is made evident at once. Extreme heat, it should be remembered, produces an analogous effect.

The cardinal point to be remembered here is that *a brief and intense application of cold is a stimulant, because it is at once followed by a corresponding reaction, while a prolonged application is a depressant.* And in the practical application of hydriatic procedures, this fact will be frequently recognized.

The general effect upon the circulation produced by cold must necessarily be traced to its impression upon the heart. Among the numerous positive and valuable contributions to scientific hydrotherapy, for which we are indebted to Winternitz, the effect of thermal stimulants upon the heart stands foremost. By means of sphygmographic tracings he learned that cold applied to the surface produced an immediate cardiac response by increasing the pulsations, but was immediately followed by a slowing of the heart's action. The opposite effect resulted from the application of high temperatures to the surface; and

here, again, the effect, being reflex, depended upon the susceptibility of the individual to impressions.

The classical experiments of Naumann, in which the trunk of a frog was left connected with the leg only by means of the sciatic nerve, clearly proved that thermic and other stimuli applied to the web produced an immediate change in the circulation of the mesentery. From these experiments he justly concluded that the irritants applied to the surface act upon remote parts by a reflex wave from the central nervous system; that intense stimulation of the surface diminishes the cardiac force and activity, dilates the vessels, and slows the blood-current; that weak stimulation of the surface increases cardiac activity, improves the force of the heart, diminishes the calibre of the vessels, and accelerates the blood-current; and that these effects continue for some time, according to the intensity and duration of the application.

That this effect upon the heart may be produced by other channels also is shown by the fact that in the heart removed from the body of an animal the application of cold produces a diminution, and that of heat an increase, in its contractions, and by the observation that the passage of cold or hot fluids through the heart has a similar effect when it is still connected with the body. Thus, it is demonstrable that the cooling or heating of the blood-current distinctly affects the cardiac nerve-ganglia.

Aside from the direct effect upon the innervation of the heart, the action of the latter may be, and is readily, influenced in two other directions. Pulse-tracings demonstrate that inasmuch as by cold impulses are conveyed from the periphery through the sensory and returned through the motor tracts, a reflex stimulant effect upon the force of the heart may be produced which offers many valuable hints in the treatment of organic and functional cardiac trouble. Moreover, a very important channel through which cardiac activity and force may be enhanced is to be sought in the relations existing between the peripheral and capillary circulation. One of the important agencies in controlling the frequency of the pulse is the resistance offered to the current of blood by the arterioles and capillaries. This resistance diminishes the frequency and increases the force of the systole, while diminution of the resistance of the arterioles and capillaries increases it.

Clinical demonstration of this effect is constantly observed in fevers. The rapid, dicrotic pulse, due to a lack of resistance in the peripheral vessels, as will be shown later, is at once changed into a more deliberate pulse of almost normal tension by the appropriate application of the cold bath. The latter acts, not by narrowing the cutaneous vessels, as is generally supposed, but by stimulating them to resume their functions of contracting upon the blood, which has been flowing through them as through a dead or paralyzed tube. Dr. Hobart A. Hare, of

Philadelphia, has made a clever *simile*, which testifies to his skill as a teacher of therapeutics: "The vaso-motor system is made up, on the one hand, of the vaso-motor nervous apparatus, and, on the other, by the blood-vessels themselves. The resistance offered to the heart by the properly acting vaso-motor nervous system, through its influence on the vessels, is identical with the friction offered to the driving-wheels of a locomotive. The locomotive is intended to meet and stand any resistance, and if the resistance be removed by slippery rails the wheels fly around ineffectually, racking the machinery and destroying its usefulness." The restoration of normal resistance in the arterio-capillaries restores the lost equilibrium between the latter and the heart. The cardiac systole becomes normal, the pulse slower and more natural. This effect I have often observed in typhoid fever, as will be shown later.

It is important to note the modifying influences arising from the impressionability of the individual, the condition of his health, the character of the disease, the method of application, and the intensity of the thermal irritant. E. Delmas Saint-Hilaire[1] has shown as the result of thermometric and sphygmographic experiments that all physiological and therapeutic manifestations produced by cold are to be explained by the impression transmitted to the nerve-centres from the peripheral nerve-endings. This primary thermo-dynamic action upon the nerve-centres is at first transferred to the respiration and circulation.

The Reflex Effect of Cold upon Cardiac Action.—This effect is frequently manifested by rapid contractions, and generally by a considerable rise of arterial tension. Shortly afterward, however, the frequency of the pulse diminishes, falling below the previous number, while the heightened tension in the vessels continues to exist. The effect of cold upon the cardiac action and the peripheral vessels depends also upon the subsequent muscular quiescence or activity of the individual. If the latter remains quiet, the heart-action is accelerated at first, but quiets down afterward. If he exercises, the pulse becomes more slow at first. The more quickly exercise follows upon the douche, the greater will be the fall of temperature, slowing of pulse, and diminution of arterial tension. The tension of the pulse is greatest at the moment of impact, when the heart-action is most rapid; as the latter diminishes the tension is also lower, but does not fall so low as it was before the douche. So soon as reaction takes place and the peripheral surfaces are warmed, the frequency of the pulse diminishes.

Physiological experiment explains these effects. When the sympathetic nerve is divided the intestinal vessels become distended with

[1] *Étude statistique et clinique du Service hydrotherapeutique de l'Hôpital St. Andral de Bordeaux, etc.*, Paris, 1879.

blood through inhibition of the power of the constrictors, while the dilators, which are probably of spinal origin, remain active. The result is a loss of tone in the entire vascular system, which endeavors to accommodate itself to the abnormal distribution of blood. Even in the vessels of the retina Basch and Hock have observed contraction, and consequent anæmia, when the sympathetic nerve was divided. In the same manner may the intestinal and retinal vessels be rendered anæmic by irritating the terminal fibres of the divided sympathetic. We have here an explanation demonstrated by actual physiological experiment, and not resting only upon plausible theory or clinical observation.

As additional evidence of the effect of peripheral irritants, Max Schueller's experiments may be referred to, which offer the most incontrovertible evidence of the influence of thermic irritants on the circulation in various parts. After trephining a rabbit without injuring the dura mater, Schueller observed through the transparent cerebral coverings the normal condition of the vessels of the pia mater. He then removed the superior ganglion of the sympathetic on one side, and applied pieces of ice upon the dura mater without any material effect upon the subjacent vessels; while a similar application upon the other side produced energetic contraction of the vessels, which continued for half a minute after the removal of the ice. In another trephined animal Schueller observed the circulation in the pia mater during various other hydriatic processes. A cold compress placed upon the animal's belly or back immediately produced continuous dilatation of the veins and arteries; the cerebral pulsation became more slow and pronounced; the respiration was deepened and retarded. This remarkable phenomenon continued a few seconds after removal of the compresses, and was followed by an evanescent narrowing of the vessels before their resumption of normal calibre.

When heat was used it was found that a warm, moist compress applied to the belly or back produced narrowing of the vessels of the pia mater and diminution of energy in the pulsations, while the latter were rendered more frequent and the respiration became shallow and accelerated. A very hot compress applied to the belly produced temporarily the same effect as a cold one. When the body of the rabbit was placed in a bath the same effect was observed, being governed in extent by the extent of surface exposed and the temperature of the water.

Schueller tested all hydriatic procedures in this manner, and thus established their value upon an exact scientific basis.

It follows from these well-ascertained facts that *by means of hydrotherapy we may exercise perfect control of the pressure and distribution of the blood.* But it must be remembered that the various compensatory

provisions which exist for the preservation of the systemic equilibrium decidedly oppose a too active interference with the elements constituting the hydraulic apparatus which is represented by the heart and blood-vessels. We know, for instance, how the distribution of blood to the organs is governed by their activity, and that *it may be increased or diminished from ten to twenty times.* It has been asserted that when the vessels of the skin are filled to their utmost capacity they may contain 66 per cent. of the entire quantity of blood in the system.

Winternitz has shown by means of the plethysmograph, which measures and records the volume of parts with precision, that an increase of volume due to the afflux of blood to the part may be readily produced in individuals subjected to various hydriatic procedures. The left arm of a man sitting in an empty tub was placed in the instrument. When the lower part of the body was covered with water at 50° F., the tracing made by the instrument at once recorded an increase of volume in the arm, which continued twenty seconds, and gradually diminished without returning to its original proportions. The opposite effect was produced by warm sitz-baths.

These brief yet positive data suffice to explain not only by theoretical and empirical observation, but upon an exact physiological basis, the enormous influence which hydriatic applications to the periphery may exercise upon the blood-supply, blood-pressure, and consequently upon the action of the heart. Not alone may the distribution of blood in various parts of the body be thus influenced, but also its morphology. Winternitz, Rovighi, Colroy, and Breitenstein have demonstrated that a marked leucocytosis results immediately after certain cold applications. This increase of leucocytes has been ascertained in health and disease. In this country the findings of Winternitz have been confirmed in the Mount Sinai Hospital by my son, Dr. H. B. Baruch, in the Montefiore Home by Drs. Abrahamson and Talmez, under my direction, and in the Johns Hopkins Hospital by Dr. Thayer, in the Jefferson Medical College Hospital by Dr. Holder. Red blood-cells attained a maximum increase to 1,860,000 in the cubic centimeter; the number of leucocytes reached a maximum of 300 per cent. increase, and the hæmoglobin 14 per cent. in eighty individuals experimented upon by Winternitz. This increase sometimes endured for an hour. In cases of anæmia the restitution of red cells to the number before the cold application was not complete, some increase continuing permanent. These changes were similar to those produced by active muscular exercise. They are an invariable incident of the reaction after cold procedures. This change in the morphological constituents of the blood after cold procedures is not to be attributed to new formation, but rather to the enormous influence upon the action of the heart and the tone of the vessels, lymphatics,

and tissues—in fine, to the changed circulation of the blood, which removes stasis of these cells in outlying districts and brings them under the vivifying influence of increased oxygenation.

Influence of Peripheral Irritation on Temperature-changes.—The effect of hydriatic procedures upon the systemic temperature in disease has long been observed. Indeed, it was the first observation recorded by Hippocrates, and has since been so constantly reaffirmed without successful contradiction that it has become axiomatic. *A priori*, it would appear that this temperature-effect is due to the effort at equalization of temperature which constantly ensues when two bodies of unequal temperature are brought into intimate contact. While this is the case in inanimate bodies, the result is quite different when the human body is subjected to temperatures differing from its own. Parts distant from the heart are more readily cooled, as are also parts whose volume in proportion to its surface is small. Indeed, it is the activity of the circulation in a part which governs its amenability to temperatures with which it may come into contact. The heat which accumulates within organs during a state of activity is not simply radiated to neighboring parts, but it is distributed to other parts of the body by means of the circulation of the blood. This is clearly demonstrable by the fact that the venous blood from the muscles or organs when functionally active is warmer than the arterial blood supplying them.

The temperature prevailing in the skin depends upon the quantity of arterial blood circulating within it. Hence the contraction and dilatation of the peripheral vessels are the chief elements in resisting cold and heat which may come into contact with them. Very little heat is produced within the skin. It derives heat, not only from the vascular tide passing through it from within, but to some extent also by direct conduction from neighboring parts. Hence the heat given off by the skin is subject to many changes. It is also influenced by the thickness of the epidermis in certain parts, and by accumulations of fat or of fluids beneath it. Therefore, thin persons cool off more rapidly than those who have an abundance of adipose tissue. Ranke says that the activity in connective tissue is less than it is in the muscular or glandular tissues, and therefore the temperature of the skin, which consists chiefly of connective tissue, is somewhat lower than that of other parts or organs. Although constant cooling going on upon the skin prevents exact deduction upon this point, it is certain that the heat-production of the skin is compensated by the heat-loss from its surface. This is proved by the temperature of the blood in the superficial veins, which is below that of the arteries. The arterial circulation must therefore be regarded in the skin, as in other parts of the body, as the most essential source of heat.

That the rise and fall of temperature in the human body depend upon its arterial blood-supply has been also demonstrated by Max Busch, who found, when cooling off a part of the skin, a corresponding rise in the neighboring parts, due to anæmia of the former and collateral hyperæmia of the latter. This, however, was followed by a dilatation of the arterioles, which is called reaction. Contrary, therefore, to the law governing inanimate objects, *the temperature of the human body never can be reduced or raised to that of its surrounding medium unless the vitality of the part exposed be destroyed.*

The entire heat-regulating arrangement residing in the skin is now made plain, and the protection enjoyed against serious temperature-invasions by the viscera, which are surrounded by muscles, is clearly accounted for.

That the human body may have its temperature elevated or lowered by being surrounded by hotter or colder media is an indisputable fact, established by many experiments, as is also its automatic protection against heat-increase and heat-loss. The application of intense heat to the surface produces contraction of the arterioles, which may go on to destruction of the tissues by withdrawal of vascular and nerve-supply. A more moderate degree of heat produces a relaxation of the surface vessels, which lose tone; the part becomes succulent, warm, and red from retarded circulation, which protects the inner organs against too rapid heating. If the surrounding medium is less hot, the surface circulation becomes more active, more heat is given off, and thus the blood brought to the surface, being cooled again, serves to protect the inner organs against too great an invasion of the heat.

On the other hand, if the body is surrounded by a temperature lower than its own, the effect again depends upon the cooling. The same change occurs from intense cold as from intense heat. Both may so contract the peripheral vessels as to destroy the vitality of the part. A less intense degree of cold applied to the skin acts, however, differently from heat, as it contracts the arterioles and capillaries, and thus weakens the force of the peripheral circulation. At the same time the blood is driven into the underlying muscles, which are endowed with more heat, and thus offer an obstruction to the invasion of injurious degrees of cold. The protection is enhanced by the reflex effect of cold applied to the surface, which produces a dilatation of the vessels supplying the muscles, and by the resultant generation of heat. As Adamkiewicz has shown, the feeble heat-conducting power of muscular tissue adds another element to the forces which tend to protect the inner organs against dangerous invasions of cold.

It has already been shown how completely the circulation of the periphery is under the influence of the central nervous system, and how the latter may be called upon to receive impressions from the

periphery and convey them back to the latter, thus completely controlling the amount of blood circulating in the skin.

It having now been demonstrated that the temperature of various parts of the body is dependent chiefly upon the amount and the rapidity of the circulation within it, it follows that the central nervous system is capable of controlling the temperature of various parts. In the skin, for instance, chilliness is a manifestation of this influence. The cutaneous vessels are contracted, heat is no longer given off freely; it is retained, and the body is protected against cold. Hence the first stage of febrile movements is a rigor. Upon this principle it would seem that the reduction of temperature by external cold application is not a reliable phenomenon. Indeed, it is held, and justly too, by some that the application of cold to the periphery produces an elevation of the body temperature by the collateral hyperæmia and consequent increase of tissue-change. Hoppe has clearly demonstrated that in a healthy man placed in a bath of 69° for a brief time the axillary temperature rises somewhat; and Juergensen has recorded a slight rise of the temperature in the mouth *during* a bath of 86° F. which lasted twenty-five minutes. This increase of temperature resulting from cold baths is constantly utilized in the treatment of chronic diseases, as will be shown later on.

Winternitz has so clearly given us an explanation of the apparent inconsistency involved in these observations that it may now be regarded as a law, that *the absolute amount of heat-abstraction does not fix the amount of heat-production, but that this is regulated by the intensity of thermic irritation of the peripheral sensory nerves.* The latter cause and control the increased heat-production by reflex action. Two cold baths of exactly the same temperature may have quite different effects upon the same individual. If the body is submerged in water of, say, 60° F., the surface is rapidly cooled, the sensory nerve-endings are stimulated, the blood is driven to the muscles, and more heat is generated within the latter. If, on the other hand, the body while submerged is constantly subjected to active frictions, the cooling will be more slow and gradual, the cutaneous vessels will convey cooled blood to the interior, and counteract also the increase of temperature by diminishing the reflex action from the surface which is the incentive of muscular heat-generation. This subject will again be referred to in the discussion of cold baths. *It only suffices here to establish the fact that the temperature of the body may, within certain limits, undoubtedly be reduced or raised by temperatures conveyed to it by means of water or air.* This has been well established by the experiments of Liebermeister, König, and Juergensen.

But the fact must not be lost sight of that changes of temperature wrought upon the human body are *compensated* for, when the influencing

thermal agent is withdrawn, by a return of the previous temperature to the normal, or by an approach to it, according to the previous condition of the body, the nature of the disease, and other agencies to be referred to later. While during the bath of from 69° to 86° the normal temperature rises, a reduction is observed after the bath, which may again, according to Juergensen, be succeeded by a compensating feeble rise. Thus, in a healthy man subjected to a bath of 95° for from fifteen to twenty-five minutes the loss of heat was equal to the normal; when the water was reduced to 77° the heat-loss was trebled, and in a bath of 68° the quantity of heat-loss amounted to five times the normal.

The influence of heat-media surrounding the body is equally pronounced. Mosler records in a bath of from 104° to 111° F. of fifty-five minutes' duration a rise to 101.6° in the mouth, and Bartels reports the rise of rectal temperature from a ten minutes' vapor-bath of 127° F. as amounting to four degrees. The writer has often seen mouth-temperature rise one degree more in the hot-air bath at the Montefiore Home, in which the head is not at all exposed to the hot air.

It would be seen that the cooling and heating effects of the baths depend upon the method, the length of time of immersion, the degree of their temperature, and the manner in which the system is capable of protecting itself against the temperature invasion. The flexibility of hydriatic procedures is thus manifested in their influence upon temperature reduction or elevation.

Effect of Peripheral Irritation on Tissue-Metamorphosis.—Ranke has enunciated the law that though the quantity of plasma and circulating albumin is constant, its production depends upon the quiescence or activity of the organs. He and Voit demonstrated that function is always connected with increased circulation in the organs, and that tissue-change is coincident with circulating activity. As the blood is the chief carrier of material for tissue-metamorphosis, it follows that any procedure by which the distribution of blood may be controlled must influence more or less the tissue-changes. And when it is considered that temperature-changes are either the cause or effect of tissue-changes, any measures which control this important factor must aid in influencing tissue-metamorphosis. That cold reduces and heat increases cell-activity is axiomatic. But these are *direct* effects, which do not so frequently come within the therapeutic domain as the *indirect* results produced by reflex agencies, and which are paradoxically contrary to these. From the cautious experiments of Liebermeister the fact has been deduced that oxidation, as ascertained by the excretion of CO_2, is enhanced by the external application of cold and diminished by the external application of heat, *so long as the body temperature is not much disturbed.* As soon as the body temperature is reduced below or raised

above the normal—which proceeding must decidedly and enduringly influence the internal temperature of the body—we have the *direct* retarding or enhancing influence referred to.

That an increased consumption of oxygen is a manifestation of the application of cold has been clearly shown by Röhrig and Zuntz.

Voit has also established the fact, and Pflüger, Samuel, Colosanti, and others have confirmed it, that non-nitrogenous matters undergo changes under the application of cold to the sensory nerves, which produces reflex contraction of the muscles. The same experimenters have shown that the opposite effect is produced by the application of heat. This, however, is limited by the degree of heat, for a very high degree will promote tissue-change, as manifested by increase of oxygen-consumption and carbonic-acid elimination, as has been shown to be the result of very long-continued low temperature. Bartels has shown that whenever the body temperature is increased by vapor or other baths, there is more urea excreted, evidencing that nitrogenized tissues participate in the conversion thus produced.

We have, then, proofs from reliable experiments that *rapid cold baths accelerate the tissue-changes* in non-nitrogenous substances, while hot baths affect not only these, but also *albumin conversion;* and that if the inner temperature is reduced below the normal, the reverse effect results.

Winternitz declares that a fair estimate of the influence of hydriatic procedures upon tissue-changes may be deduced from the fact that among several thousand cases treated in his establishment, 56 per cent. gained weight, 30 per cent. lost, and in only 14 per cent. no change in weight occurred. He concludes that it cannot be denied that the thermal and mechanical influences which compose hydrotherapy produce in the majority of cases such *changes in tissue-metamorphosis* that eventually an increase of flesh results.

Inasmuch as, according to all experimental researches, abstraction of heat produces an increased excretion of CO_2, and a larger quantity of oxygen is taken up; and as the products of retrograde metamorphosis from nitrogenous matters appear abundantly during the period of reaction, as well as salts and inorganic material, and despite these effects the body-weight seems to increase in a large proportion of cases, the conclusion is unavoidable that hydriatic treatment not only increases retrograde metamorphosis in all directions, but also enhances the building up of tissue. Therefore, this hydrotherapy is capable of *promoting tissue-change* in every direction.

My clinical observation in the Montefiore Home, which receives only incurable cases, confirms the views of Winternitz, that an improvement in the general condition and weight of a large number of cases, whose hopelessness has been attested by previous unsuccessful treatment

and by every diagnostic sign, is proof that cold-water applications, carefully adapted to each case, improve the appetite, deepen the respiration, refresh every organ, and thus infuse an increased energy into the glandular and other functions which contribute to tissue-metamorphosis. The effect of temperature-enhancing procedures are, as has been already shown, equally striking. The action of the heart and the respiration are accelerated, the blood-pressure and blood-distribution are notably changed; and these marked alterations must make a decided impression upon the nutritive processes. Anton Frey[1] gives as the result of numerous experiments with Turkish baths a positive increase of urea. Still more pronounced is the change of uric-acid excretion under Turkish and Russian baths, amounting sometimes to a threefold increase. The increase is greatest immediately after the bath, but is demonstrable even several days afterward. The quantity of phosphoric and sulphuric acid is also increased.

Godlewsky's exact experiments, quoted by Frey, demonstrate conclusively that Turkish baths induce a positive acceleration of oxidation of nitrogenous substances (nutrient and tissue albumin), which continues several days. That non-nitrogenous substances may also be converted by these baths is constantly observed in the fact that corpulence may be reduced by them if the supply of fatty foods and fluids is diminished. Experiments on animals also have demonstrated this.

Another evidence of the enhancing effect of these baths upon tissue-change is found in the increased absorption of oxygen by the blood and by the excretion of more carbonic acid. These effects are greatly enhanced by the temperature-reducing procedures which are a part of the Turkish bath. The great loss of salts and water resulting from the hot-air bath must affect the composition of the blood, which must compensate the loss by drawing upon the tissues and intercellular fluids. It is reasonable to suppose that this active process induces pronounced changes in the parts involved, and thus influences tissue-change. Indeed, it has been definitely determined by C. Schmidt (quoted by Winternitz) that the withdrawal of salts, and especially of alkaline chlorides, from the blood is followed by a diffusion of albumin from the tissue-fluids. Schmidt has ascertained that there exists between the blood-salts and the plasma-albumin a constant reciprocal relation of equivalents—viz. that the blood takes up for every nine parts of albumin one part of salt; the reverse also holds good. Hence the blood-plasma must become much richer in albumin after sweating. It cannot be disputed that such a change in the chemical constituents of the blood must contribute to the acceleration of tissue-metabolism, as evidenced by the increased absorption of oxygen and excretion of carbonic acid

[1] *Volkman's Sammlung*, 332 S., p. 3018.

and nitrogen. The recent remarkable contributions by Scholz[1] to the treatment of chlorosis by sweat-baths may be cited as clinical proof of this physiological phenomenon. His sphygmographic charts and exact records are entitled to proper consideration.

Another element contributing to acceleration of tissue-changes is *muscular activity*. This has become an axiom in physiology, and it has been shown how cold applications increase the action of muscular fibres by reflex channels. The result of all reliable investigation points to the fact that oxidation, indicated by reaction of CO_2 and ingress of oxygen, is considerably increased by cold, and that the effect of warmth is antagonistic to this process.

We have therefore a truly physiological basis for the statement that hydrotherapeutic procedures increase tissue-metamorphosis by enhancing the normal activity of the organs. There is no doubt that by modifying the thermic influence of an application, either primarily or by means of the reaction called forth, one may modify the functional activity of the various organs.

Influence upon the Secretions and Excretions.—That perspiration is readily produced by heat is a common observation; but gases and toxic substances like urea, and micro-organisms like the Staphylococcus aureus, may thus, be excreted is not generally known.

Reaction.

In the application of cold procedures the chief aim should be to secure reaction. This process is a normal result of the effect of cold upon the skin; it manifests itself in a widening of the bloodvessels of the skin, which is in proportion to the duration, temperature, and force of impact of the cold water. Even when the abstraction of heat is aimed at, we may, as Winternitz has shown, obtain far better effects when the cold water is applied with friction or other mechanical impact. To modify this reaction lies in our power, and affords the hydrotherapist a little known but flexible weapon in many disease-conditions.

Technique of Hydrotherapy.

The first principle of all hydriatic procedures which the reader should impress indelibly upon his mind is the necessity of an exact and precise execution of their technique. The flexibility of hydrotherapy is so remarkable that the most contradictory results may be obtained from procedures apparently similar, and the object aimed at may be totally defeated by imperfect or improper methods. In a paper read before the New York State Medical Society in 1889, I mentioned

[1] *Die Behandlung der Bleichsucht mit Schwitzbäden*, etc., von D. Fried. Scholz, Bremen-Leipzig, E. H. Mayer, 1890.

the case of a young but able hospital physician and teacher who expressed abhorrence of the bath treatment of typhoid fever because he had seen, while an interne, a nurse in his hospital succumb to it under the management of his able visiting physician, who was also a professor of the practice of medicine. When I asked him to explain the method adopted, he replied: "We endeavored to reduce the temperature by wrapping her in a sheet, placing her on a Kilbe's cot, and sprinkling her with ice-water." That such a proceeding contributed to the death of the woman I have no doubt. The brief physiological data above given will explain how the blood was driven from the surface to the inner organs, and, there being no effort made to obtain reaction by friction, the poor woman had her life-blood almost frozen in the peripheral vessels, whose coats were paralyzed rather than stimulated, as will be shown later on. The most ignorant hydropathic nurse understands that an *iced sheet* should never be wrapped around a patient without active friction; and here was an otherwise excellent teacher of medicine violating the most palpable rules of the water-treatment and infusing a prejudice against it in the mind of a young man which broader culture has fortunately removed. This gentleman now confesses himself "a complete convert to the Brand method." Thus erroneously have many capable men argued upon hydrotherapy and fostered the prejudice which the lay and medical public entertains against cold water. Even in the application of so simple a procedure as an enema, which depends for its effect upon mechanical distention, the mistake of using too small a quantity of water will, as every one knows, defeat the object. We do not direct our patients to go the drug-store and obtain some quinine or strychnine, or other medicament. We give a prescription, directing the mode of preparation, dose, frequency of repetition, etc. I plead for the same care in prescribing hydrotherapy, which is many-sided in its effects and far more potent for good and evil than most medicaments. The temperature, duration, and pressure should be as carefully prescribed as is the dose of a medicine, for by changes in these the most varied effects may be produced. If a fever patient be placed into a full bath at 70° and allowed to remain fifteen minutes, he would emerge from it cyanotic and shrivering, his temperature undiminished, and his whole body enfeebled, while the same bath given with active friction would stimulate and refresh him. The effect of a douche at 60° under a pressure of thirty pounds is quite different for a douche at the same temperature under ten pounds pressure. The former stings and stimulates; the latter chills and enfeebles. Why then should physicians continue to order patients cold baths without stating temperature or duration? Even the temperature of the bath-room should be prescribed if we would facilitate

reaction, which is the most important object. Instances of misapplication of hydriatic procedures come under my daily observation. Is it, then, to be wondered at that so many failures are reported when men regard the use of cold water as the only or chief principle of hydrotherapy? Hydrotherapy is a term applicable to the utilization of water in any form, of any temperature, by various media or alone. Modern medicine has enlarged the field of hydrotherapy, inasmuch as it now includes the injection of hot water into the various cavities of the body—of the stomach for certain forms of dyspepsia, of the vagina for certain pelvic troubles, of the uterus for hemorrhage, of the rectum for dysentery, and steam as a hæmostatic. These methods for local effects will be considered later.

The minute subdivisions of hydrotherapy introduced by the hydropaths, as head-baths, elbow-baths, and wrist-baths, will here be omitted, and only those methods described which the writer has found practically useful in his own experience or in the practice of others.

In order to win the profession over to a more general adoption of water as a remedial agent I have deemed it proper to simplify its application, and only refer here to the most approved methods, whose mode of action is simple and explicable upon rational principles. These methods are—1st, the ablution; 2d, the sheet bath; 3d, the wet pack; 4th, the dripping sheet; 5th, the half bath; 6th, the full bath; 7th, the douche; 8th, the sitz bath.

Ablution.—This is the most simple and yet least frequently used procedure for a therapeutic effect. To wash the face, hands, and neck is a daily practice with all civilized people. *This is a true ablution.* How rarely it is practised as it should be—over the entire body—in disease will at once appear. True, many medical men who are not hydrophobic order sponging for their fever patients. This is refreshing if the nurse happens to understand that it consists of an ample application of water to the skin, and not a mere sweeping of it with a damp sponge. Ablution is better practised with the bare hand or a linen wash-rag, which may convey a dash of water into actual contact with the skin. The entire body may be gone over, and the moistened parts may be, in high fevers, allowed to dry; otherwise they should be gently mopped up by soft linen napkins, to avoid reaction.

The *rationale* of this method is as follows: Friction being produced by the hand, the superficial vessels are somewhat dilated; the blood contained in them returns cooled to the interior, and is replaced by warm blood coming from it. Thus a most refreshing effect upon the innervation and circulation is produced, which is conveyed to the nerve-centres.

The *indications* for the use of ablutions are many. In the early

stages of all febrile affections cautious ablutions are valuable. They serve to prepare the patient for more intense heat-abstractions, while they cool and refresh him for the time being. They also furnish a valuable index to the reactive capacity of the patient, which serves as a guide to future procedures.

A most important method which I adopted at first in very feeble patients, and now apply in all persons affected with chronic maladies who are prejudiced against water treatment (the vast majority), is the dry pack, followed by ablutions. The patient is snugly enveloped in a coarse woollen blanket for a sufficient length of time to become thoroughly warm. Each part of the body is now exposed in succession, subjected to ablution with water usually at 65° (reduced daily two degrees), and then dried. After the entire body has been gone over the patient is thoroughly rubbed dry again and sent out into the open air.

The next step in the hydrotherapeutic training of the patient follows in several days. He is made to stand nude in a tub of water at 98° or 100° while he is rapidly washed down by an attendant, or if strong enough does it himself, with water at 70°, gradually reduced daily to 50°; good drying and friction finish the procedure. In a few days he is prepared to undertake any of the more heroic procedures without shrinking.

The Sheet Bath.—This is a much neglected but exceedingly useful measure. It is well adapted to cases under the influence of elevated temperatures, and may be used, as will be shown later, as a refreshing agent in some chronic diseases. The technique consists in conveying cold water by the medium of a sheet or towel, of fine or coarse texture, placed upon the cutaneous surface. The patient is wrapped in a linen sheet, wrung not quite dry out of water at a temperature of from 60° to 70°, so that it clings to him at all points. When it is applied standing his feet may be placed in a tub containing water at 95°, to prevent chilling. This practice will be referred to later. The sheet bath I desire to describe now is to be applied in bed. A rubber cloth and a blanket having been spread to protect the bed, the wet sheet is placed upon it. The patient, after having his face washed and a wet towel wrapped around his head, is now laid upon the sheet with outstretched arms. The right side of the sheet is brought around his body, and so laid across it that its edge touches the sheet at the opposite side. The arms are now brought alongside the body; the left portion of the sheet is now brought over the left arm, across the body and right arm, and tucked in along the right side of the body, a fold being pressed in between the lower extremities and the upper corner tucked in around the neck.

By passing the flat hands over the entire body the wet sheet is made to cling to the irregularities, and its warmth soon indicates the rapid

equalization of temperature between the sheet and body. Now small quantities of water are poured with one hand from a vessel or a sponge upon a limited part of the body, beginning with the chest. With the other extended hand rapid passes are made over this spot until it becomes a little warmer. Thus successive parts of the body are treated except the forearms, hands, legs and feet. This is continued until the sheet appears to be uniformly cooled off or the patient's teeth chatter. He is now removed upon another portion of the bed, dried, and made comfortable. It is in our power to modify the effect of such a bath by using a sheet of finer texture or making it more wet by pouring larger quantities of water over it. Care should be taken that the chilling produced by the first impression is not prolonged into a shivering, but that gentle reaction is always produced in one spot before another is treated. This can readily be done by not repeating the water application if the part is slow in warming or if it ceases to warm under the chafing hand. The wet towel around the head should receive an occasional affusion also.

The value of this bath is very great, and its rationale is as follows: A most useful and yet mild antifebrile effect is produced, which, following ablutions, will not antagonize the patient or his friends, and yet will afford a most intense antipyretic effect, arousing the dormant nerve-energies, brightening a dull patient, and improving those functions which depend upon quickly-responding nerve-centres for their integrity and efficiency. The first impression of cold upon the sensory nerves stimulates them, and the effect is rapidly conveyed to the nerve-centres, as described above. All the reflex effects of cold applications are thus evoked. The peripheral vessels contract, but dilate again under the chafing hand. Being filled with blood, the latter is cooled off by the cold water poured upon it, until the peripheral vessels again contract and drive the cooled blood within. Thus a constant gentle, because partial, abstraction of heat is established, which even feeble patients may bear with impunity if the foregoing directions are judiciously followed.

In cases which do not possess facilities for bathing in tubs this sheet bath furnishes a good substitute for the full or partial baths to be described later. They may be given upon a cot or upon a blanket-covered table, or on the floor near the bed to avoid wetting the latter. In rural districts or in poor families great advantage will thus accrue to the patient, who may, if necessary, be deluged with water in this way.

In all febrile affections with high temperature, except in chest or abdominal diseases, this bath is applicable. In the exanthemata, when high temperature, with or without stupor and cyanosis, gives evidence of "suppression" of the eruption, the sheet bath with its attendant

frictions is an admirable remedy, having the advantage over medicinal antipyretics that it stimulates the heart, deepens the inspiration, and increases oxygenation and diuresis, thus fulfilling other very important indications besides temperature-reduction. He who has seen a child with scarlatina tossing and moaning with a temperature of 104° or more, with mottled skin and shallow breathing and decreased urine, cooled and refreshed and enlivened by this bath, will never forget the relief and satisfaction derived from so simple a procedure.

In chronic affections, when the patient is too feeble to take the dripping sheet, this bath may be administered.

In feeble patients, partial sheet baths, made by placing fringeless towels over the trunk and treating it in sections as above described, will prepare the case for the full sheet bath or relieve local internal hyperæmia if applied over the affected part.

The flexibility of the procedure is self-evident. Modifications to fulfil various indications will suggest themselves to the physician who masters its rationale and objects.

The Wet Pack.—This application of water by means of a linen sheet is not, as is usually believed, the invention of the hydropaths, but was first suggested by Lucas, an English physician, in 1750.

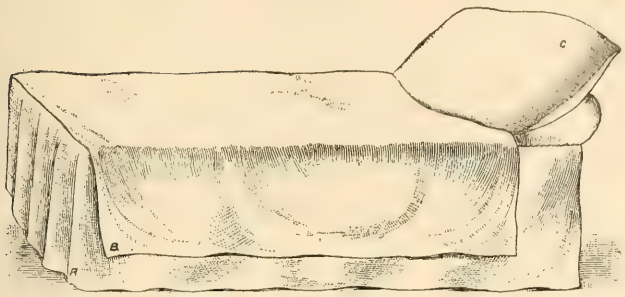
Just as we modify the effect of powerful medicinal agents by the method of administration, so may the effect of water be modified, except that the changes which may thus be wrought are more numerous and the effects more striking.

The wet pack is *not really a wet sheet*, but a *damp sheet*, by the application of which we aim to envelop the patient in a vapor-bath of his own creation. It is applied as follows: A good blanket is smoothly placed upon a cot which has been covered with a hair mattress. A coarse linen sheet—or a linen tablecloth may be substituted, because of its being more apt to be found in most households—is now dipped in water varying from 70° to 50°, as may be indicated, always beginning with the higher temperature and lowering it from two to six degrees daily. This sheet is now wrung out more or less according to the object in view, and is then opened and spread as smoothly as possible upon the blanket. (See Fig. 70.)

The patient, having a wet napkin or a soft towel pinned over his head, is laid upon the sheet, so that its upper border touches the nucha. The attendant now rapidly envelops him in the sheet, taking care that no two surfaces remain uncovered in approximation, and that he does not sacrifice comfort to neatness. Fig. 71 shows the sheet lying over the right side of the patient's body, its edge upon the chest and abdomen, while the attendant presses some folds down between the arm and body.

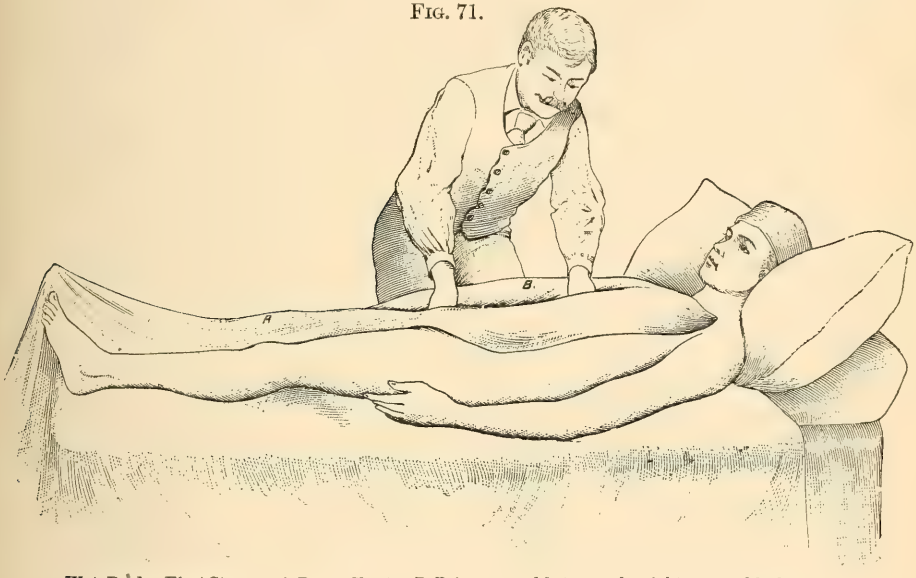
Fig. 72 shows the sheet folded over the entire body, the folds being pressed between the arms and body and between the lower extremities.

FIG. 70.



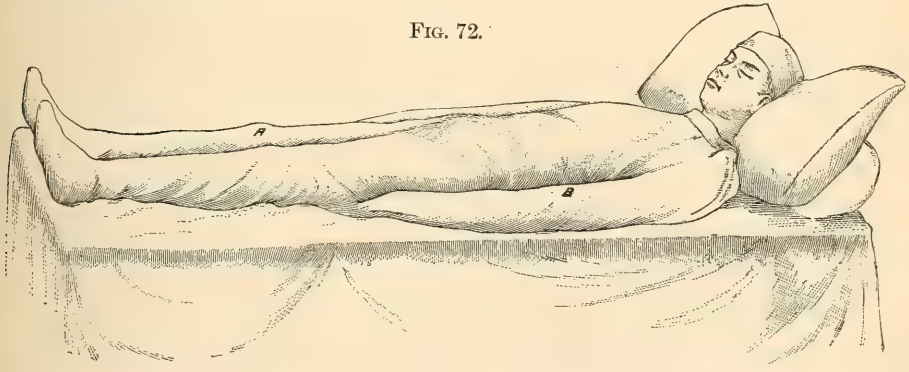
Cot prepared for Wet Pack. *A*, Blanket. *B*, Damp Sheet. *C*, Pillow.

FIG. 71.



Wet Pack—First Stage. *A*, Damp Sheet. *B*, Being pressed between the right arm and body.

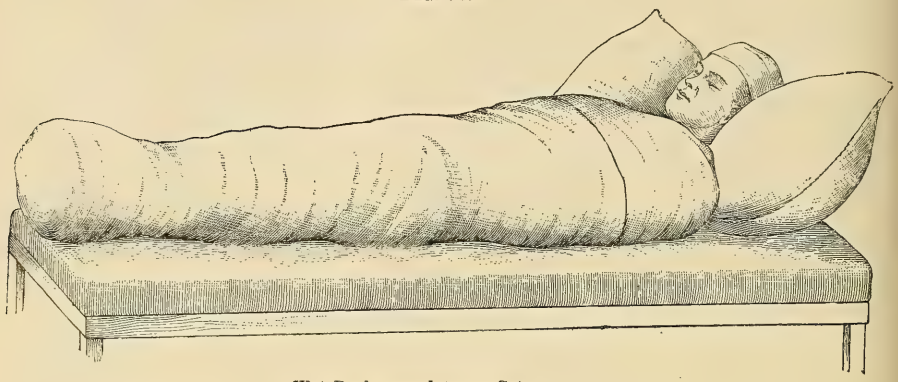
FIG. 72.



Wet Pack—Second Stage. *A*, Damp sheet between legs. *B*, Sheet folded between body and left arm.

The sheet thus having been snugly applied, and secured at the neck, with care not to embarrass respiration, and below the feet, the patient

Fig. 73.



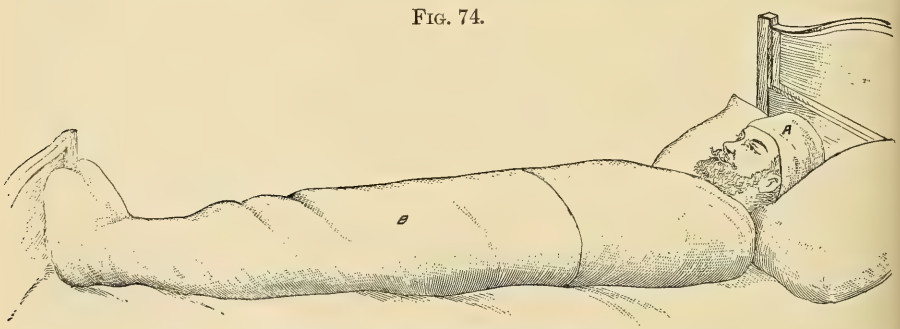
Wet Pack complete on Cot.

is completely covered by the blanket in the same snug manner. Figs. 73 and 74 show the pack complete.

This is called the full wet pack, which may be modified by including only the trunk of the body—trunk packs—or its upper part alone. The length of time in which the patient should remain in it is from half an hour to an hour. If given for the *antipyretic effect*, the sheet should not be so thoroughly wrung out as if for the vapor-bath, and the pack should be changed every ten minutes until the necessary result is achieved or the first signs of deficient reactive power ensue.

The object of the wet pack in chronic diseases differs, as will be

Fig. 74.



Wet Pack on Bed. *A*, Wet towel on head.

shown, from that aimed at in acute pyrexiæ, hence the modification in technique referred to. It is always advisable to open a window while the patient is in the pack, closing it before he is unwrapped.

The use of the wet pack depends upon the following facts: The

difference of temperature between that of the body and of the damp sheet produces the effect of a sudden shock to the peripheral sensory nerve-endings. The result, as has been previously indicated, is a contraction of the cutaneous vessels and the driving of blood from them into the underlying vascular area, chiefly the muscular twigs. This stage lasts, however, only a short time, according to the age and vigor of the patient, his sensitiveness, and his power of reaction. A chill rarely occurs a few minutes after the wrapping, especially if a glass of cold water be given him, and the current of blood sets in again toward the periphery, whose vessels now begin to dilate. The sheet becomes warmer by the more rapid flow of blood to the periphery, from which heat can be but slowly given off, owing to the bad conducting media with which it is surrounded. Finally, perspiration may occur.

The pulse, which on the immediate contact of the body with the sheet, is accelerated for a brief time, becomes more slow, diminishing often from ten to twenty beats, and rising again toward the termination of the pack, when the body is thoroughly warmed. Max Schueller's very well known experiments on animals show that the vessels of the pia mater become dilated in the cold pack, but contracted after the surface becomes warm. The respiration is somewhat accelerated. The fact that the blood then circulates more slowly through the lungs, although the latter act more rapidly, would point to an increased oxygenation of the blood in the wet pack. The body being practically enveloped in a vapor of its own creation, the skin gives off a good deal of moisture, and with it other matters, if Quirolo's investigations on the elimination of noxious materials through the perspiration in infectious fevers be correct. If the pack is prolonged to several hours, so long as the sheet retains a temperature below that of the body the continuous flow of warm blood to the periphery excites cutaneous-nerve stimulation, and the process of in- and outflow are repeated, the vessels being subjected to a discipline which is invaluable in some affections, as will be shown.

If the pack cannot be prolonged in chlorotic or weak individuals, who possess feeble heat-productive power, if chilliness becomes pronounced, and warmth does not succeed it or is followed by chilliness, the wrappings should be removed. Such individuals may have their reactive capacity assisted by active friction or other heating procedures prior to entering the pack. It is an error, however, for that reason to raise the temperature of the water in which the sheet is dipped. *It is a law in hydrotherapy that the nerve-stimulus (hence the reactive power) is enhanced by the intensity and brevity of the application.* A sheet wrung from water at a temperature of 60° in a patient who has been previously warmed up (not by active exercise, however) will bring on

reaction much sooner than one wrung out of water at 80°. A coarse sheet, well wrung out, is here indicated.

The wet pack calls out all those physiological effects which have been referred to in the first part of this essay—viz. a heightened functional activity in the nervous and muscular systems, and consequent enhancement of the processes contributing to nutrition and tissue-change. In addition to these, the quiescence which follows the commotion induced by the first stimulus of contact, and the subsequent equalization of temperature between the body and the surrounding media, furnish an important therapeutic agent. Probably, through removal of the acid fatigue-products, this passive state of the nerve-centres is enhanced; hence many sleep in the pack, an evidence of its calming effect. This reduction of functional nerve-activity in the muscular and nerve-tissues prepares them for recuperative processes, since, according to Ranke, these structures receive nutritive elements chiefly if not entirely during a state of comparative inactivity.

The enforced rest for one or two hours produces a favorable influence also upon the hyperæsthetic condition of some neurasthenic and hysterical cases—a discipline which may be rendered therapeutically valuable by judicious modifications adapting it to each particular case.

The Wet Pack as an Antifebrile Agent is here separately considered, because its technique is quite distinct from that just described, which is chiefly used in chronic affections. In febrile diseases we have no remedy that will refresh the patient more than this, and render him comfortable. If the temperature is high, say 103° or higher, the sheet is wrung not entirely dry out of water from 75° to 60°. The patient is wrapped precisely as in the method just described, except that the blanket may be lighter and no additional bed-clothing be heaped upon it. So soon as the enveloping sheet feels warm upon the chest, another blanket and sheet wrung out of water of from two to five degrees higher temperature are prepared on the opposite side of the same bed or upon another near the first. The patient is wrapped within these, and again removed into a third as soon as he warms up the second. This is continued about every ten minutes until from five to eight packs have been given or the sheet ceases to warm up rapidly. A prolonged *chilliness is a positive signal for cessation* of the pack. The true antipyretic effect of the wet pack has been carefully studied by Liebermeister, who declares that five packs of ten minutes' duration are needed to produce the same antipyretic result as one full bath at 65° F.

This method presents a mild form of hydriatic antipyresis, which may not be objected to by the patient and friends as much as the full bath. It becomes, therefore, an important measure which may be utilized as a preliminary to introduce more heroic treatment.

All wet packs must be succeeded by some procedure which checks the relaxation of the cutaneous vessels and restores their tone. This is a rule which the scientific as well as the empirical hydrotherapists insist upon. After the process of packing is finished, then in chronic diseases, when the patient is fairly strong and able to move around, his feet are freed from the blanket and also loosened somewhat and encased in slippers. He now walks or is carried to a tub half full of water at from 70° to 60°. The blanket and sheet are rapidly removed by the attendant, and the patient bathes his face and chest in the water and seats himself in the tub. The attendant now dashes the water upon his back and shoulders by means of a little pail or basin, while he does the same with his hand upon the chest and abdomen and practises friction upon his extremities. After from three to eight minutes he is removed and thoroughly dried.

In febrile cases or in cases of debility a simple ablution with water at 50°, followed by friction or a sheet or towel bath, which will be presently described, may terminate the packing. This is a repetition of the stimulation of the cutaneous vessels, their contraction and subsequent dilatation, and the ebb and flow of blood from and to the periphery. In chronic cases this *finale* is an additional stimulus to tissue-change or to absorption of pathological products; in acute diseases the antifebrile effect is heightened by this half bath or by the cold ablution.

As a discipline for the neuro-vascular and glandular apparatus of the skin it is the most useful method. The so-called hardening effect is marked as a protection against colds and catarrh, and the restored tone of the cutaneous nerves offers an important adjunct in the management of depreciated neurotic patients. Usually the appetite improves strikingly, sleep is promoted, and general robustness results after a longer or shorter continuance of this method.

Partial Packs in the form of damp compresses may be used over inflamed or hyperæmic parts. These are well known in the treatment of asthma, of pulmonary troubles, of congestion of the abdominal viscera and glands, or in other hyperæmias. In all but the last two cases they are applied as stimuli to the superficial vessels lying over the inflamed parts. If the cloths are well wrung out of water at from 60° to 50°, the first impression of cold passes rapidly away, and is followed by a pleasant warmth due to the superficial hyperæmia. These compresses should lie upon the parts snugly, and be covered with flannel to retard evaporation and escape of heat until they are nearly dry. They should be renewed after the part has been rapidly bathed with cold water, and repeated as often as necessary. We possess no more soothing, calming, and derivative absorbent agent. In superficial inflammatory affections the linen compress should be thinner, not wrung

out so completely, and not covered, and be more frequently repeated. When the object is to reduce local hyperæmia, a better plan is to lay single strips of linen upon blocks of ice and apply them frequently to the inflamed part. In purulent conjunctivitis, for instance, in threatening phlegmon, in contusions, sprains, and cutaneous inflammations, this method of applying cold has been found eminently useful. It should be observed, however, that if reaction is allowed to follow each application of the iced cloth, its object would be defeated—*i. e.* the constringing effect. Hence frequent continuous repetition is a *sine quâ non* in this instance, while in other cases the pack or compress must be prolonged until it is nearly dry, to obtain the superficial relaxing effect from the vapor-bath produced by it prior to the application of the terminal cold.

The Abdominal Compress is one of the most valuable of the local packs. It is made by forming several folds of a coarse linen towel of sufficient breadth to reach from the ensiform cartilage to the pubis, one of which is then wrung out of cold water. After this is applied the remainder is rolled around the body so as to retain snugly the position of the first, or four folds of coarse linen wrung out of cold water are applied and secured by a flannel bandage.

The Therapeutic Indications for the Wet Pack may be found in most subacute or chronic diseases involving faulty tissue-metabolism and consequent or coincident deposit and afflux of pathological products to parts.

In chronic articular rheumatism, especially if accompanied by anæmic manifestations, in muscular rheumatism, gout with or without deposits, in catarrh of the gastric or intestinal tract, the indications for the wet pack of an hour's duration, followed by a rapid cooling procedure, will be plain to the reader who has carefully studied its *modus operandi*. In the above-mentioned affections many positive curative changes have been attributable to this procedure, in the observation of the writer, after his failure with all the most approved medicinal and non-medicinal remedies. Precise rules for the management of such cases cannot be laid down in this brief article, nor are they necessary if the *modus operandi* is understood.

In cases of anæmia undoubted effects in the improvement of the condition of the blood, as evidenced by the general aspect of the patient and from hæmometric observations, have been recorded by the author, as well as by many writers on the subject.

In phthisis, when the heart is irritable or excitable, there is no more powerfully calming measure than wet packs of the whole body until it is moderately warm again—that is, from one-half to three-quarters of an hour—followed by a rapid cool rain-bath. Professor Winternitz speaks highly of chest compresses, prepared with napkins folded in a triangle,

which after being well wrung out of cold water are applied so that the apex of the triangle lies over the ensiform cartilage, while the other corners are respectively folded over the shoulders; or it may, in the event of the posterior portions of the lung being involved, be placed over the back. Or a wide roller of linen may be wrung out of water and applied in a figure-of-eight over the entire chest. All these must be covered by flannels.

Winternitz claims that the vapor from the damp cloth and the uniform heat evolved from it produce a condition favoring organic processes. He regards the constantly enveloping gentle warmth as acting beneficially in evolving reactive inflammation, limitation, separation, absorption, or cure of diseased tissues.

In acute croupous and catarrhal pneumonia the local chest-pack is an invaluable measure. A linen compress, three- or fourfold, should be applied with care, well wrung out of water at 50°, and covered by a flannel or stout cotton bandage to prevent dampening of the patient's clothing. The latter would seriously defeat the object, as any experienced nurse knows. Care in applying it without too much disturbance of the patient is important. The compress should be changed every half hour if the temperature be high. Besides his own clinical experience, the author may cite so good a teacher as Felix von Niemeyer,[1] who says: "It has been of great interest to me that both Bartels and Ziemssen strongly commend the application of cold compresses to the chest, as proposed by me in croupous pneumonia, as by far the most efficient treatment."

When the temperature is high and the pulse and respiration are very rapid in the early stages of pneumonia of children, the full wet pack is indicated. Its soothing effect is marvellous. That it requires some courage on the part of the uninitiated to wrap a child with pneumonia in a sheet wrung out of water at 65° a recent experience of the writer illustrates. While in the act of doing so the anxious father expressed his feelings by saying to me: "Doctor, this seems like heroic treatment, but we trust you." My reply was emphatic when five minutes later I pointed to the child which had been tossing in great distress all night, and who was now slumbering peacefully, its cyanosed features having become calm.

In all febrile conditions from whatever cause, especially when high temperature with enfeebled circulation is present, wet packs are calmative, not only reducing temperature, but soothing nerve-erethism and aiding in the diminution of effete material by stimulating the heart and encouraging diaphoresis and diuresis. The medicinal antipyretics do

[1] *Textbook of Practical Medicine*, translated by Drs. Humphreys and Hackley, D. S. Appleton & Co., 1875, p. 195.

not fulfil so many indications, but owing to the greater simplicity of their administration may be preferred in all non-infectious fevers.

Strümpell, whose work, translated by Shattuck of Harvard University, is now a textbook in our best colleges, says (page 173): "In the treatment of lobular pneumonia of children the best remedies are tepid baths with affusions and general wet packs applied several times a day. The higher the fever is, the oftener must these be repeated; with moderate fever the child may stay in the pack for two or three hours."

Drs. J. Kaufman and Baer[1] give some exact investigations made in Kussmaul's clinic on wet packs and compresses in pneumonia. The temperature of the water was from 59° to 68°, and the patients were entirely enveloped for half an hour—longer if they felt comfortable; which is the custom in Kussmaul's clinic in cases of the exanthemata. Almost without exception the patients felt pleasantly during the cooling, and much relieved afterward; dyspnœa was diminished, and often the most restless patients were calmed into slumber. Although the temperature was not much reduced, the object achieved was a powerful derivative to the skin with all its beneficial results. In most cases the blood-pressure was increased at first, but quickly considerably reduced, as measured by Busch's instrument, while the pulse was reduced in some cases and not in others.

In cases of acute nephritis, in which Kussmaul had often seen in his consultation practice serious dyspnœa with bad, even lethal, results from hot baths, the cold wet pack acted far differently. The subjective condition of the patient was greatly improved, an energetic derivative to the skin was instituted, and if the patient was afterward covered with a blanket energetic perspiration ensued. The blood-pressure was regularly diminished by the packs, and returned very late to its original height.

In cholera infantum and summer diarrhœa, when decided pyrexia is present, the abdominal wet compress is far superior to poultices, which are so much in vogue, because they dilate the cutaneous vessels quite as much by the reaction they induce, and thus promote any probable derivative effect, while they are equally soothing and aid in reducing elevated temperatures.

The Hot Wet Pack.—In this connection a method may be referred to which, though it has a limited application, is invaluable. Instead of wringing the linen sheet out of cold water, it is dipped into water at 110°, well wrung out and spread upon the blanket, as in the cold pack. The patient is wrapped as in the latter, and allowed to remain for an hour. He is now rapidly removed to the side of the bed upon which he is to lie, lightly rubbed over with a rough wash-rag

[1] *Berlin. klin. Wochenschrift*, July 9, 1888.

squeezed out by the hand, dipped into water at 65°, quickly dried, and left alone.

This method in the author's practice has been found useful only in obstinate insomnia. Its effects are explicable upon the evidence of Max Schueller's experiments on rabbits.

The Hot Blanket Pack is a procedure that has long been utilized by physicians not otherwise familiar with hydrotherapy. It is prepared by placing a rubber sheet and one or two woollen blankets upon the bed. A heavy woolen blanket is now wrung out of water at 110° by two persons twisting it in opposite directions. This is spread upon the dry blanket and rubber sheet, the patient placed upon it and wrapped with it like a mummy. The dry blankets and rubber sheet are now wrapped over the damp blankets, and the patient is allowed to remain in this pack from half an hour to two hours. By this means the superficial vessels are at once dilated, and continue so under the influence of the artificial vapor. The functional activity of the skin is increased, perspiration ensues, and peccant matters are eliminated. The superficial hyperæmia acts as a general poultice and as a derivative from the viscera. Tension of the blood-vessels is decreased and a general relaxation ensues.

The Therapeutic Indications for the Hot Blanket Pack are numerous. In suppression of urine the writer has obtained marked effects from this pack. In cases of uræmia it is a resource which should not be omitted, and this fact is testified to by numerous clinical records. Among many cases of this character are those of B. C. Hirst,[1] who records two very severe cases of eclampsia during and after labor at the Maternity Hospital in Philadelphia, which, apparently beyond hope, yielded in an astonishing manner to the profuse diaphoresis following a hot wet blanket pack after other remedies, including venesection, had accomplished nothing.

I find the objections to the hot pack to be that it cools off too rapidly before the patients can be well wrapped in it, and that it does not continue hot. A better procedure is the following:

Local Hot Packs.—These are prepared by wrapping the patient in a dry blanket, and applying old pieces of blanket of sufficient size well wrung out of water at as near the boiling-point as possible. The latter is done by using a clothes-wringer or a piece of stout canvas half a yard square, to two of the sides of which handles are secured projecting beyond the upper and lower edges. The hot, wet pieces of cloth are laid upon this wringer, which is now twisted in opposite directions by its handles. Care should be taken that every particle of unabsorbed water be squeezed out, for only by this means may scalding of the parts be avoided. If they are well wrung out, the attendant

[1] *University Medical Magazine*, July, 1890.

may handle them with impunity : he applies them to painful parts by raising the enveloping blanket, and again secures the latter snugly. Thus a constant hot vapor is created under the blanket, which produces profuse diaphoresis ; the direct heat from the wet cloth produces hyperæmia over the affected parts, and thus relieves local pains. These applications are frequently renewed for from half an hour to an hour, until the patient is in a profuse perspiration. He is now quickly dried ; receives a rapid ablution with water at 65°, is dried, and placed on the side of the bed he is to occupy.

The therapeutic indications for this method explain themselves. Its chief application is in uræmia, and in rheumatic and neuralgic affections. In recent lumbago and sciatica I value these applications above all other external or internal remedies. They require skill on the part of the attendant. I have seen one bad case of scald produced by imperfect wringing.

The Dripping Sheet.—This is a perfectly distinct procedure from the wet pack, and, as it is frequently confused with the latter, its description follows most usefully at this point.

My experience having been originally with the greatly depreciated patients at the Montefiore Home, I devised a method which I have retained in more robust cases. To avoid the chilling effect of cold water upon the feet, the patient is placed erect in a tub containing twelve inches of water at 100°. A linen sheet, the coarser the better, is now dipped in water at 70°, which is reduced daily two degrees until 48° is reached. This is thrown over the patient from behind, covering the head and body, so that it clings to the latter (Fig. 75). The attendant now makes rapid passes with both hands, beginning anteriorly and posteriorly, so as to produce friction and afflux of blood to the surface, increasing the surface irritation by occasional gentle tapping and slapping with the outstretched hands. When parts of the body feel warm to the attendant's hands, cold water at from 40° to 70° is thrown upon them from a basin or cup and friction is renewed.

Another method is executed by wrapping the sheet from the front, around the patient's body alone, while he stands with outstretched arms. Placing the left upper corner under the patient's right axilla, he secures the left edge by holding it with the arms against the body, while the attendant carries the right edge under the left axilla, the patient now replacing this arm alongside the body, and then, carrying it over the back, throws it across the right shoulder and thence around the neck and upper chest to the left, where it is tucked under. The patient's arms being uncovered, he aids in the friction in front.

A recent work on the treatment of diseases of the nervous system describes the dripping-sheet as made by *wringing* a sheet out of cold water and rubbing the patient with it. How a sheet can dry after

being wrung out does not seem to concern the author. He expresses himself opposed to an elaborate technique in hydrotherapy, but by thus confusing one procedure with another he confuses instead of simplifying. The dripping sheet contains all the water it is capable of absorbing, hence the heat abstracted is enormous, while the sheet wrung out of cold water is more stimulating by reason of withdrawing less heat, and by the friction with the sheet instead of upon it. The difference in the technique results in a decided difference of effect.

Fig. 75.

Dripping Sheet.

Great care should be taken in feeble patients to make the friction mild, in high states of pyrexia to use a finer sheet and more and colder water, and in chronic cases to use a coarser sheet and less water and more active friction. It must always be borne in mind that it will make less demand upon the patient's vitality to apply a sheet wet with water at 60° than at 95°. By shortening the duration and producing friction, reaction will be favored when the lower temperature is used. After the dripping sheet the patient should be rapidly dried, and if able should be sent into the open air; if not, he should be well covered and the windows opened, in order to obtain the full advantage of the deeper inspiration.

The Sheet Bath.—This is the application of the dripping sheet in the recumbent position. Lay the patient upon it and wrap him snugly within it; then rub with the flat hands as above, and pour colder water from a cup or pitcher upon successive parts which friction has warmed, until warming no longer ensues. This is an excellent substitute for the full bath when the latter is not practicable. After the entire body has thus been rubbed and cooled the blanket upon which the drip sheet has been spread is wrapped around the patient, and he is allowed to fall asleep; or he may at once be dried and removed to a dry cot. This bath may be repeated every three hours, as required.

The *rationale* of the dripping sheet is explicable upon the general principles above referred to. The sudden cold impression upon the entire body stimulates the peripheral nerves actively. This stimulus results in a reflex action. The blood is driven from the superficial

vessels, only to return quickly wherever the friction-producing hands dilate them. Hence an active vascular ebb and flow is constantly in operation, which relieves internal hyperæmia, removes vascular tension, relieves the heart if embarrassed, reduces the pulsations, and invigorates its muscular tone. Respiration is greatly deepened from the moment the cold wet sheet strikes the large surface exposed to it. The inspiration being deepened while the blood circulates more slowly through the lungs, oxygenation with all its advantages is enhanced.

Therapeutic Indications.—This most powerful procedure, rendered more stimulating by the assistance of the attendant, is useful in anæmia and chlorosis, in which an improvement of the cutaneous circulation is so imperatively demanded, and in which tissue-metamorphosis must be promoted. In all chronic diseases in which the blood-making function is defective the dripping sheet is one of our most valuable resources. In phthisis I have found this the most useful of all procedures when properly adapted to the case, and when the latter has been prepared for it by hydriatic procedures of gradually increasing intensity. It should always be adapted to the patient's reactive capacity; the room should be warm and all the preparations for rapid drying be made before he is subjected to it. There is no advantage in a higher temperature of the water than 70°, because even the most feeble will, if properly prepared, react better if the temperature is lower. The effect may be enhanced by a dry pack preceding it, which accumulates heat upon the surface, and thus precludes the removal of any internal heat from an anæmic patient.

In acute exanthemata, when the temperature is rising and there is evidence of sluggish circulation in the slowness of the eruption, the dripping sheet, with active but gentle friction, will "bring out the rash" by equalizing the circulation, relieving the heart, and deepening the breathing.

In feeble digestion, in chronic catarrh of any organ, in visceral engorgements or infarctions—in short, in all diseases in which a refreshed circulation and innervation may lead to a "renewal of life," as Dr. King Chambers aptly expressed it—the dripping sheet is the procedure *par excellence.*

The Half Bath.—This is prepared in a tub containing about eight or ten inches of water of such temperature as the case in point demands. The pressure of the water is thus avoided, that the attendant may more readily practise douching and friction. A wet towel being tied around his head, the patient is seated in the tub; the bath water is poured and dashed over his back, head, and shoulders with the attendant's right hand, while he practises friction with the left, and the patient does the same on the anterior portion of the body. Occasionally

the patient dips his whole body into the water for a minute or two, while the attendant continues the friction. The temperature of the bath water may be lowered if a more decided impression is desired. The bath is continued for from five to twenty minutes, the patient and attendant continuing active friction. By these measures there is a constantly recurring shock and reaction. The lower the temperature in this bath, as in others, and the more brief the cold application, the more active will be the stimulus and reaction. Winternitz regards the half bath as far more temperature-reducing than even a colder full bath without motion. The active and unimpeded friction operates favorably as a heat-abstractor; heat is given off to the water and chilling is prevented. If coma or delirium is present, this bath produces an awakening effect upon the nerve-centres by permitting of affusions from some height. The duration of the half bath should be from ten to thirty minutes, and the temperature of the water in high fever should be from 60° to 75°, using the higher temperature of water on the lower part of the body, and the lower temperature on the higher portions of the body. If, however, the reaction is likely to be sluggish, the lower temperature is far more useful, if *briefly applied* with good friction and douching. The skin must show some bright redness, not a dark mottled hue. The efficacy and pleasant effect of the half bath depend upon the skill and judgment of physician and attendant.

Winternitz dwells upon the effect of properly-executed half baths upon respiratory difficulties. In pneumonia with exudation, dyspnœa is relieved or cured when the skin has been made hyperæmic by a good half bath with affusions.

The principle of peripheral vascularization referred to in the therapeutics of the full bath is worthy of careful attention in the treatment of the now too-often fatal pneumonia. If the theory is correct—and I have little doubt of it—that the right ventricle may be unloaded, and thus relieved by vascularizing the large cutaneous area, we have in the half bath a powerful agent to counteract heart failure and improve oxygenation of the blood.

In all fevers involving a depreciated nervous system, as manifested by ataxia, delirium, and even coma, the half bath is indicated.

In chronic affections the indications are numerous. The half bath, offering all the advantages of other hydriatic procedures, may be resorted to as one of the changes which impress the patient. In constipation Winternitz recommends buckets of water to be thrown from some height upon the patient's abdomen while he lies in the water. After the bath he is quickly dried and rubbed and ordered to exercise in the open air. In Winternitz's establishment at Kaltenleutgeben, I have seen the half bath used more frequently than any other procedure. He applies it with success in chronic inflammatory conditions of the

spinal cord, at a temperature of from 74° to 86° F., the latter when lancinating pains are frequent and intense, of eight to ten minutes' duration, without friction. The body is gently kneaded in the water and the back is simply bathed. When the pains diminish the baths are made cooler and shorter. The anæmic condition due to compression of the vessels by exudation in the diseased parts is relieved by the not too forcible vascular interchange resulting from such a bath. Eulenberg and Charcot having demonstrated reduced tension of the pulse in ataxic patients, these baths, if cautiously given, serve to counteract these conditions and improve local nutrition.

The Full Bath.—This consists of a tub about two-thirds full of water, the duration and temperature being adapted to the purpose in view. It differs from all other hydriatic procedures by reason of the more prolonged contact of the nude body with a large amount of water. It is well to suspend an inflated air-cushion from the head of the tub for the head to rest upon, and a water-filled cushion may be placed on the bottom of the tub to receive the nates. Thus the patient's body may be entirely covered by water, so that his chin just clears it.

The Brand Bath.—In acute diseases, in which this bath is usually applied, and in which the patient demands the utmost freedom from physical and psychical disturbance, a screen should be placed between the bed and the tub to prevent him from witnessing the preparations. The tub should be on rollers, so that it may be filled in or near the bath-room and thence conveyed to the bedside.

While the patient is in the bath a blanket should be spread upon his bed, and upon this a soft linen sheet and a towel under the head-piece. Hot bottles or bricks, wrapped in stockings or pieces of blanket, should be in readiness to warm the feet, which not infrequently remain chilled after a full bath.

Before the patient is placed in a cold full bath a stimulant ($\frac{1}{2}$ ounce to 2 ounces of brandy) may be administered. The sexual organs are lightly covered by a napkin, the face and chest are laved with ice-water, after which he is gently placed in the water. The shock of the cold submersion may cause the patient to declare that he cannot breathe, or it may produce trembling. Usually, if the temperature is below 70°, he will remonstrate with the attendants that he is very cold and that he cannot bear it, but patience and avoidance of flurry or excitement, firmness in insisting that no harm shall befall him, and extreme gentleness, will overcome his objections.

It would be well to avoid sympathetic bystanders, who will by the expression of their faces or by actual remonstrance defeat the proper execution of the procedure. The latter requires the courage of conviction derived from actual practice or careful investigation, so great is the temptation to obey the importunities of the patient and his friends.

After the patient is submerged one or two persons should gently pass the flattened outstretched hands over successive parts of the body. By these frictions, as Ernst Brand of Stettin, the originator, has shown, the superficial cutaneous vessels are dilated, and because of the reaction induced by it the skin, which was of a dead white when the patient entered the bath, becomes of a ruddy hue under the hands. It may become cyanotic if friction does not actively counteract the contraction of the arterioles produced by the cold impact. The patient must not be removed until the allotted time has expired. The best guide to the safety of the bath is the patient's condition. If he complains of being chilly or shivers, he must not be removed until chattering of the teeth confirms the statement. Cyanosis of the lips or face is an immediate signal for removing the patient to his blanket. Many physicians are deterred from continuing the baths sufficiently long (fifteen minutes, according to Brand) when the pulse becomes small and thready. But this is due to the local effect of the cold upon the radial arteries. *Unless the thready pulse is accompanied by an increased number of beats, danger from collapse is not present.* Frictions over the body and limbs should never cease during the bath.

When fifteen minutes have expired, or the patient's condition demands it, he must be gently lifted by two persons, and be held suspended for a minute over the tub while the superfluous water drains off and the napkin is removed. He is now laid upon the sheet, and quickly wrapped from head to foot. If the temperature has been above 103° F., he is covered with the blanket and dried in five minutes; if below 103° F., he is dried with the sheet and towels, his gown replaced, and he is covered by the bed-clothes, hot water being applied to the extremities. At this point nourishment is most readily administered.

The Graduated Full Bath.—This method was introduced by Von Ziemssen, the editor of the celebrated *Cyclopædia of Medicine*, as a modification of the Brand bath. It is better adapted, he claims, for private practice when patients object to the sudden entrance into cold water.

Preparations are made as in the bath just described, except that the tub is filled sufficiently to cover two-thirds of the recumbent body. The water being warm, no shock ensues. The continuous dashing of water upon the body by the attendants, and the gradual lowering of its temperature by the addition of cold water (ice-water may be used if a rapid change is desired) while warm water is being removed, constitute the difference between these baths. Friction is practised, as in the Brand bath. As the graduated bath lasts half an hour, and the water is reduced to 68° as rapidly as possible, the patient really lies quite as long in cold water as in the Brand bath.

The mode of action of the full cold bath is explicable upon the general principles laid down. The thermal stimulus is intense, there being a difference between the temperature of the body and the water of from thirty to forty degrees. The active cutaneous circulation in the early stages of fever protects the patient against injurious effects. If the submersion is brief or if muscular action during submersion could be maintained, as it is after Turkish baths, no harm can ensue. But in fever cases the lack of tone in the vessel-walls seriously impairs reactive power. Hence frictions are of the utmost importance. Without them much harm may be done, and to their neglect is ascribable much of the prejudice existing against the cold bath in fevers. I well remember a case at one of our large hospitals in which the temperature was reduced from 106° to 100° by wrapping the patient in a sheet and saturating the latter with ice-water squeezed from a carriage sponge. That the patient succumbed (with a lower temperature) is explicable upon the physiological effect of *such* a procedure. The blood, driven from the contracted peripheral vessels to the interior, was not permitted to return to the surface. Hence the cooling was only a surface cooling, ascertainable in the mouth. As the rectum shows one or two degrees higher in many cases, because the mouth is more superficially situated, so may the rectum temperature be depressed still lower by such positive cooling without indicating a lowered temperature in the deeper tissues. How much more rational is the Brand bath, which by continuous chafing of the surface stimulates the cutaneous vessels to dilate, filling them with blood, as is indicated by the suffused redness seen under the chafing hand! The blood is cooled in these dilated vessels, and rapidly carried into the interior to be exchanged for hot blood coming from within. This interchange produces a cooling of less intensity than the continuous chilling of the surface in the bath without friction, but it is more positive and enduring.

Aside from this palpable effect, we have the authority of Leyden, Traube, and others that the rise of temperature in fever is in part due to diminution of heat-dissipation from the surface because of partial paralysis of the arterial coats. Friction, as Weyrich has proved, increases water-elimination, and it, together with the stimulus of cold, overcomes the paresis, and thus increases heat-dissipation. The nerve-centres receive not only the refreshing impressions from the surface, but they are directly supplied with cooled blood, and thus their functions are approximated more to the normal, and the organs depending upon them are favorably influenced. The rapid pulse, indicating that the heart is struggling to overcome the effect of enfeebled innervation, is reduced. The heart, which has been laboring to compensate for the loss of assistance from the contractility of the arterial coats, which Marey and Winternitz have shown to be in abeyance in infectious

fevers and to be the chief cause of heart failure, is relieved, because the superficial arterioles are stimulated to alternating dilatation and contraction by the chafing and subsequent impact of cold water.

Thus, all the indications in the treatment of fever are fulfilled: the temperature is reduced, the nerve-centres stimulated and refreshed, and the integrity of the organic functions maintained.

In chronic diseases the cold bath is utilized as a plunge after heat-elevating procedures, combined or not with swimming exercise; and so we have the mechanical action of the volume of water and the increased pressure upon the peripheral vessels, which must increase the pressure within and improve the force of the heart. Reaction is increased by this active disturbance of circulatory conditions: there is increased tissue-change and the temperature is elevated. If it is continued too long without muscular movements or friction in a patient not having an elevated temperature, the lips and skin become cyanosed, the face and extremities become pallid, cramps and chills ensue, and serious consequences may result, which an active muscular movement would prevent.

The shock from the thermic contact in the plunge is somewhat similar to that of the douche.

The therapeutic indications of the cold full bath must be considered separately, because this bath has a distinct history which is as remarkable as it is unappreciated.

Typhoid Fever.—Without entering into details, it may be stated that to Ernst Brand we are indebted for an earnest, intelligent, and courageous effort to introduce to the profession this treatment, which had since the day of Hippocrates passed through many vicissitudes, again and again appearing under the ægis of some noted men, like Hahn, Boerhaave, Hufeland, Currie, and others. It is nearly thirty years since Brand, unknown at that time outside of his private *clientéle* at Stettin, published his work on the *Hydrotherapie des Typhus.*

In order to exhibit the true claims of this method, and render it more clearly appreciated, I cannot urge too energetically the fallacy of regarding a high temperature as the chief danger in typhoid fever. Until this fallacy is laid away among the rubbish of pathology, fever treatment will continue to be unsuccessful. Let me not be understood as espousing the idea that the elevation of temperature is of no consequence, or to claim that it is a conservative process. Far be it from me to utter such absurdities. The elevated temperature is but one symptom; it is not in itself a dangerous one. This is evident from the enormous rise of temperature physicians in the South so often observe in malarial fevers without evil results, from the same comparative innocuousness of excessive temperature in recurrent fever, and in the aseptic fever so ably described by the lamented Volkmann and other

surgeons. Professor Welch has shown that animals may be kept at high febrile temperatures for three weeks without manifesting serious symptoms. The respiration and pulse were quickened, but the arterial tension remained unchanged. The real dangers in typhoid fever are due to the effect of the toxic agents circulating in the blood, plus the high temperature, and not the latter alone. Were the high temperature the chief element, we would find a specific therapeusis in the powerful antipyretics, whose action is as reliable as is that of veratrum viride on the pulse. The idea that inflammatory diseases could be effectively throttled by venesection or by the pulse-reducing veratrum was short-lived, because it was based upon the one symptom alone. It may be justly argued that the combating of another symptom—elevated temperature—is equally fallacious. Those who practised venesection knew well what comfort it afforded: the throbbing head, the insatiable thirst, the wild raving, ceased as if by magic. The urine began to flow, the skin and mouth became moist, the patient was calmed into gentle slumber. Lulled into a false security, the life-blood was again and again drained away at a time when its integrity was most essential to the maintenance of the vital powers. What wonder then that an enlightened pathology swept this but too-enduring therapeutic octopus from the field and trampled it into everlasting obloquy?

Shall antipyretics (in typhoid fever) fare better? True, their immediate effects upon the economy are not so disastrous. They, too, render the patient comfortable—they too relieve the throbbing brain, moisten the tongue and skin, and quiet the patient. But they too destroy the living protoplasm by chemical action. They dry up, as Vinay has shown,[1] the fountain whence most of the products of retrograde metamorphosis must issue from the system; they enfeeble the heart and nerve-centres; they destroy the hæmoglobin, as Lepine, Semmola, and Stokvis testified in the Paris Congress of Therapeutics of 1888. Thus they damage those vital processes whose maintenance in vigorous function is really the chief aim of all therapeutic endeavor in typhoid fever.

The chief danger lies in the facility with which they may be administered and the rapid yet positive results which ensue. These are temptations to which the inexperienced physician is exposed, and which he will find it difficult to resist unless he be informed by the investigations and clinical observations of others. The systematic use of antipyretics is therefore as objectionable in typhoid fever as are all other spoliative measures. The chief aim of treatment is to sustain the vital powers until the disease has run its course.

The chief agent in the management of typhoid fever is the cold bath. Practical observations in thousands of well-recorded cases have demon-

[1] *Lyon Médical*, 1888.

strated that the systematic application of cold baths has reduced the mortality from typhoid fever to a point below which it will probably never fall. A treatment which shows 1 per cent. mortality in 1223 cases collated from five different sources, including private practice and civil and military hospitals, may be regarded as nearly perfect.

In several papers read before and freely discussed in our medical societies I have endeavored to impress upon my colleagues the true import of the results achieved in Germany and France by the cold-bath treatment of this disease. Statistics are proverbially misleading when marshalled to sustain a special plea. They may be readily distorted, even by one whose object it is to present them fairly and judicially. In a question of such enormous import as the saving of a human life and the lessening of human suffering it would be criminal to endeavor to sustain preconceived notions by claptrap arguments or fallacious statistics. I have therefore approached this question imbued with the solemnity and import of the issues involved.

Moreover, let it be remembered that I am not advocating the cause of a bantling of my own creation—that I am not striving to achieve fame by the dissemination of my own discovery. As a member of a profession whose highest aims have ever been not only to relieve their fellow-men by direct ministration, but to impart knowledge obtained in the pursuit of the latter, it is my sole purpose to fulfil these aims.

Therapeutic deductions must be based upon theoretical considerations and clinical results. The hydrotherapeutic management of typhoid fever rests on both. In this disease we have an infectious process whose presence is accepted almost universally, although its origin and concomitants are still *sub judice*. Whether it be a process due to the presence of micro-organisms, whose multiplication in the system produces the fever, or a conservative agency by which the disease-germs are to be destroyed and eliminated; whether the local process be the cause or the result of the infection, the latter is manifested by a group of symptoms which unmistakably point to its presence. We have an elevated temperature of characteristic course, accompanied by increased heart-action, with a tendency to feebleness; more or less depression of the nervous system, evidenced by debility, headache, delirium, and impaired digestion, with marked absence of hydrochloric-acid secretion; the skin and kidneys too are crippled in their important eliminating office. That the impairment of all those organs, upon whose functions the maintenance of life depends, may be traced to the toxic agency acting upon the nerve-centres, is pretty clearly demonstrated. We have no more positive evidence of the fact than that presented by the clinical observation that in the treatment of this disease, in which many changes have been made, those methods have been most effective which have aimed to maintain

the action of the nervous system in the most vigorous condition. The so-called stimulating and supporting treatment has survived all other methods, because it aims to maintain the integrity of the nervous system, upon which all the vital functions of the body depend. The cold bath has again and again been demonstrated as the most effective stimulant to the nervous system. When a woman faints we have a complete picture of nervous depression affecting the circulation, respiration, and probably all other functions. Is not a dash of cold water our chief remedy? Is there any medicinal remedy equal to it for arousing the nerve-centres? The first impression results in a deep inspiration; a fresh supply of oxygen is furnished to the blood, which once more courses through its wonted channels, bringing color to the pallid cheek, restoring fire to the glassy eye, and consciousness to the stricken brain.

Trite and simple as this remedy seems, it offers us most convincing proof of the stimulating influence of water upon the nerve-centres. In typhoid fever we have it upon authority which we dare not question that the cold bath refreshes the nervous system; that it deepens the respiration; that it moistens and cleans the tongue, improves the appetite; that it steadies and slows the pulse; that it improves the digestion; that it increases the quantity and improves the quality of the urine; that it removes stupor and delirium. In short, it lends vigor and tone to the entire system, and approximates the condition of the patient so nearly to the normal that his entire aspect is changed. This testimony comes from men like Ziemssen, Bartels, Nothnagel, Hoffman of Leipzig, and other clinical teachers who have cautiously tested and deliberately weighed the results of hydrotherapy at the bedside.

That the cold-bath treatment has survived the onslaughts of prejudice and unpopularity during a period in which so many important developments in medicine have occurred—one of which alone, the discovery of the truly powerful chemical antipyretics, would have sufficed to wreck it—must be conceded as the most convincing test of its clinical value.

The material from which evidence of its surpassing value may be culled is simply enormous. Indeed, no therapeutic question offers so abundant and varied a statistical array of facts. The comparative merit of various methods of treatment is best illustrated by the record of the well-known garrison hospital at Munich, which furnishes us such clear, incontrovertible, bedside observations that it alone may be relied upon to stand as a bulwark of defence against all attacks. Vogl, who is the chief of this military hospital, has been gradually led to the abandonment of all other methods in favor of the strict cold bath by studying the records of his institution for forty-seven years! During this period every known method of treatment had been in

vogue in 8325 cases of typhoid fever. The various types of the disease are clearly pictured in his works, as well as its management, from venesection to therapeutic nihilism, with all intermediate methods. As has been the fashion of late, antipyretics and baths have also had their sway.

During the past fifteen years a comparative study of 889 cases shows the results of the bath treatment to be superior to all others, despite the changing types of the disease. The cases not being selected for either station, the following is the result of the strict bath treatment and a moderate bath treatment combined with antipyretics:

Results.	Strict Bath.	Combined Method.
Mortality	2.7	6.7 per cent.
Average stay in hospital	47.3	40.7 days.
Percentage of complications	68.2	102
Average number of diarrhœas per person per day	0.7	1.9

There is no doubt that these papers of Vogl are the most fair discussion of this question extant. Indeed, it may be justly said that no question in therapeutics has received so complete a survey, inasmuch as we have here a truthful picture of the disease in all its phases, the treatment in all its fashions and forms over nearly half a century, in an institution under constant disciplinary supervision, and among patients of almost the same physical condition, receiving the same diet, and doing the same work. For a comparative estimate of treatment no better data can be imagined. Additional statistics may be offered, but they would only confuse, because they must include old and young, rich and poor, males and females, under varying conditions.

Suffice it to summarize, that while by the combined treatment the average mortality has been reduced to a lower point than ever before—viz. from 40.3 per cent. (1843) to 7.6 per cent.—at times the rate of mortality under this treatment reached almost as high as that of the purely expectant treatment. On the other hand, the systematic Brand treatment—a bath at 65° F. for fifteen minutes every three hours so long as the temperature remains at 103° F.—never allowed the mortality to exceed 4.7 per cent. in the last seven years, and averaged 2.7 per cent. Juergensen reports even a smaller mortality—1 case in 217.

The *Brand method*, which the author introduced into this country, is now adopted in most large hospitals. It is practised and taught by Delafield, Peabody, Gilman Thompson, and others in New York; by Osler in Baltimore, and Tyson in Philadelphia, and in other cities. The author has not found it difficult to practise it in private families after explaining its advantages.

A treatment which in a large number of cases offers us a reduction of mortality to about 3 per cent. in a disease which destroys from

20–40 per cent. of all persons attacked, treated otherwise, demands a trial; and we are guilty of criminal neglect if we permit prejudice, difficulty of execution, or any obstacle to deter us from adopting it. I am convinced that even in the sparsely-settled country districts this treatment may be executed. If we are not able to obtain a good bath-tub, any large wash-tub may be utilized. The patient is seated in it, half recumbent, with his feet outside, wrapped in a blanket, while his body is bathed and rubbed as described in the half bath.

The following is the practice from which the best results have been obtained: It is of the utmost importance to begin water treatment early, even before the diagnosis is clear. A mild (90°–75°, ten to fifteen minutes) bath can do no possible harm, but is useful in all febrile affections, including pneumonia and the exanthemata. If typhoid fever does not develop, the patient's comfort will at least be enhanced, and his recovery from the less severe form of fever hastened if it does develop. Thus valuable time will be saved. Sponging is inefficient. Ablution is more refreshing; then the half bath, then the graduated bath, and lastly the Brand bath, as described, may follow in succession. Stupor, delirium, and coma always demand the bath if the patient's temperature is below 103°. The patient is placed in a bath of 95°, and basins of water at 60° are poured over his head and shoulders until he is aroused or shivers.

The Brand bath treatment and the substitutes and preparatory measures have been described here in detail, because they are applicable to all infectious diseases. The chief point to be remembered is that the object of this bath is to arouse the nerve-centres to action when depressed by toxæmia. This stimulation results in a restoration of all the depreciated functions to as nearly normal a condition as is practicable. Reduction of temperature is one of these results; but it is not the chief aim of the cold bath, nor even its most important object.

The Exanthemata.—In these diseases ablutions at 75° and baths at 80°–75° are exceedingly useful. In *scarlatina* we have the comparative statistics of Dr. Reimer[1] of 3460 cases, treated by various methods, 978 being treated by hydrotherapy. Cold compresses to the head, thorax, and abdomen acted favorably upon the heart, but did not lower the temperature much. Good results were obtained from cold envelopment, combined with affusions of water at 54° to 57° in the empty tub; affusions in a gradually cooled bath were favorable, but sometimes collapse ensued.

The gradually cooled bath did not influence the temperature according to Reimer, and produced general weakness, which in some cases

[1] *Archives of Pediatrics*, 1890.

was of a threatening character. He recommends plunging the patient into water at 57° and subsequent rubbing and enveloping in blankets. The brief impact of the cold produces a stimulating reaction which aids the heart by giving proper tone to the cutaneous vessels.

In *measles* the same treatment is valuable; especially in malignant cases is the plunge into water at 70°, with subsequent rapid drying, to be commended. Von Becker[1] reports 800 cases of measles, with very slight mortality, treated with baths at 95° for ten minutes, followed by wrapping in woollen blankets for an hour. The perspiration was thus dried off and a cold wet compress wrapped around the chest, changed every two hours. A wet compress was also placed upon the head.

The testimony of Ziemssen,[2] who quotes Currie's remarkable results by cold affusions in 150 cases, which are equivalent to the sudden and brief dipping of the body into cold water practised by Reimer, is equally favorable. He says: "The most recent times have again proved the high value of hydrotherapy in scarlatina. The energy of the water treatment must of course be governed by each case; the earlier the patient comes under treatment, the higher the temperature, and more resisting the organism, the lower should be the temperature of the baths and the affusion. In advanced cases stimulants must precede the use of the graduated cold bath."

Pneumonia.—The therapeutics of this fatal disease have passed through as many vicissitudes as those of typhoid fever. Bloodletting, venesection, and veratrum viride pass before the mind's eye in gaunt and sorrowful procession. Expectancy, too, which rescued us from the foregoing measures, has not even given as good results as in typhoid. Would that another Brand should arise to teach us boldly the use of the bath in this disease! It is true we have already much to encourage us in the writings and statistics of Juergensen, Fismer, Penzoldt, and others. To place these on record here may serve as a nucleus for a future steady advance in the right direction. Dr. A. H. Smith brought before the Tenth International Medical Congress in Berlin the true rationale of the heart-failure which kills in pneumonia, when he not only taught that the right heart is laboring because it is unequal to the extra work, as Juergensen showed twenty years ago, but also that this difficulty may be ameliorated by encouraging and maintaining a dilated condition of the peripheral circulation, and that stimulants alone are utterly inadequate to relieve the heart in pneumonia.

Juergensen recommended very cold baths, preceded by stimulants, and gives some remarkable results. But his heroic treatment has found few imitators. I believe that the *cool full bath,* with friction, meets all the indications, which are to deepen and slow the respiration, reduce

[1] *Kinderarzt,* Nov. 3, 1897. [2] *Pathologie und Therapie des Scharlachs,* 1888.

the temperature, invigorate the heart, stimulate the nerve-centres, and *dilate the cutaneous vessels* by continuous friction.

I have resorted to baths of 90°, reduced to 80°, with extraordinary success in pneumonia of children and youths, and in adults with temperatures over 103°. The temperature reduction is most marked. I have seen a temperature of 106° reduced to 101° on several occasions, which is impossible under any bath in typhoid fever. The bath is given for from fifteen to twenty minutes in a tub near the bed, as indicated above in typhoid fever, and the patient is rapidly dried. Professor Penzoldt[1] furnishes the following deductions from treating 2200 cases in Erlangen; "If the indication is, besides reducing temperature, to improve the circulation, respiration, and cerebral activity, and to further expectoration, *preference should always be given to a cautious bath treatment.*"

Fismer[2] says that in Basle a reduction of 9.6 per cent. in the mortality of pneumonia has been achieved in 200 cases by the bath treatment.

The most useful procedure in the pneumonias of adults and children alike is the cold compress. Three folds of old linen are stitched together and provided with slits under the axillæ, so that they can be readily made to envelop the entire chest. This compress is wrung out of water at 60° for adults and 65°–70° for children, wrapped around the entire thorax, and covered by a piece of flannel similarly cut and snugly secured by pins. When the temperature is above 103° the compress is only partially wrung out; as it lowers it should be more thoroughly wrung out; when it reaches 100° the wet compress should be replaced by the flannel. Renewal is required every half hour or hour. The author has found this method less disturbing in adults than the cold or cool bath, and equally effective, because it fulfils every indication. It deepens inspiration, increases the contractility of the peripheral cutaneous vessels, thus strengthening the heart; it arouses the brain at each application, and counteracts the toxæmia.

In the pneumonia of children we have the testimony of Baginsky that all the "indications are well fulfilled by cold compresses around the thorax, repeated every half hour or hour. When properly employed, they may be life-saving."

In catarrhal pneumonia a more rapid application of colder water —dipping into water at 75°, for instance—would be effective, as is recommended by Strümpell and others.

Rheumatism.—In the acute form the application around the affected joints of compresses more or less wrung out of water at 60° and covered by one layer of flannel is a most useful adjuvant to the

[1] *Münch. med. Wochensch.*, 1890, No. 36. [2] *Archiv. f. klin. Med.*, 1873, p. 445.

salicylic-acid treatment, shortening the duration and ameliorating the pains of the disease.

In the hyperpyrexia of acute rheumatism Wilson Fox, Medley, Murchison, Sydney Ringer, Charcot, and others have reported reductions of temperature of from five to eight degrees. I reported a case of this kind in the *Transactions of the South Carolina Medical Association* for 1873. Every large joint was enormously swollen; the temperature began to rise rapidly, and had reached 106° when I had the patient gently placed in a tub of cold water and ice applied to the joints. The temperature fell, great relief ensued, and the treatment was continued by means of local cold wet compresses; and after failure of the usual alkaline and other treatment—the salicylates were not then in vogue—hydrotherapy absolutely cured this patient.

Chronic Diseases.—The full bath is resorted to by the French and Germans in *piscines*, which are large marble or stone reservoirs with flowing water, which is constantly renewed. They are used as plunges after heat-elevating measures for the purpose of increasing retrograde metamorphosis in scrofula, gout, uric-acid diathesis, polydipsia, and as an *auxiliary* in syphilis. They should not be used on feeble or anæmic persons, in pulmonary or cardiac diseases, nor in affections of the brain and spinal cord.

The Warm Bath.—The uses of this procedure are so different from those of the cold full bath that it demands a separate description.

The technique consists in the simple filling of a tub with water at any temperature near that of the body, say 90° to 106°. The patient lies quietly in it, and obtains the effect of warmth, moisture, and water-pressure. The action of the warm bath upon the body has already been referred to. Its principal uses are soothing or calming to the nervous system, producing sleep and allaying reflex instability when applied for brief periods of time. There is, however, one method of using the warm bath which has been in vogue since Langenbeck devised it in 1855[1] for the treatment of extensive burns and wounds. The continuous warm bath, called by Hebra the permanent bath, is made by suspending a sheet in the tub as a hammock. The patient lies upon this surrounded by water, which is kept in an equable temperature (warm) by a proper arrangement of in- and out-flow. Hebra used it with great success in large burns, ulcers, and pemphigus. In the latter he retained patients in the bath for several months (except when they desired to defecate), not only without detriment, but with success, the affected parts being protected from the air and kept constantly cleansed and soothed. In more recent literature we find the remarkable results obtained by Riess.[2] From practical application during twelve years in

[1] *Deutsche Klinik*, No. 37. [2] *Berlin. klin. Wochensch.*, 1887, No. 29.

one of the principal Berlin hospitals he derived important results in several hundred cases, comprising paralysis of the lower extremities, paralysis of the bladder and intestines, and in bed-sores, in chronic meningitis, in apoplexy with unilateral contractions, in tetanus, chorea, and sciatica, in dropsies, and in chronic articular and muscular rheumatism. These results would warrant us in applying this bath in any of the above cases when they refused to yield to other treatment.

In *typhoid fever* also Riess reports good results in lowering temperature and diminishing complications. He applies a temperature of 88° F. whenever the body-temperature reaches over 102°, and removes the patient when it is reduced to 100° F. At first the effect is unpleasant, but the patient soon becomes accustomed to this bath. From three to nine hours are required to effect the reduction indicating removal. His clinical charts are very interesting, being examples of one thousand cases. The mortality was 8.5 per cent.; the duration was, singular as it may seem, almost always shortened. All symptoms improved after the first quarter hour, during which time the heart seemed sometimes embarrassed.

This method has a good future. It is certainly less heroic than cold baths, and if properly arranged demands little trouble. When cold baths are objected to, the permanent warm bath offers an excellent substitute.

The Douche.—When water is brought from a height or otherwise issues forth under atmospheric pressure through a tube, in a more or less circumscribed stream, upon localized portions of the body, the application thus made is called a *douche*. This procedure was invented by Pietro Tussignano in 1336. It did not become popular, however, until Priessnitz established his rude mountain-stream douche, which doubtless damaged as many people as it relieved. He gathered a stream of water, falling from a great height, into a wooden gutter about six feet above the head, and allowed it thus to fall upon his patients, who were forced to visit it in all kinds of weather.

The penetrating and inventive genius of Fleury recognized the value of the procedure, and eliminating its disadvantages, constructed it into one of the most useful and powerful nerve-stimuli known to the profession. He systematized its application, and his success in practice brought so many followers that the douche treatment has become a distinctive French method. During a recent European journey I found it almost exclusively used in the numerous hydrotherapeutic establishments in Paris. Duval, Keller, Beni-Barde, and others use it constantly—indeed, almost exclusively. While in Germany the wet pack is the most popular procedure, the douche is not excluded there to the extent that the pack is neglected in France.

The douche is furnished by water delivered under pressure of from

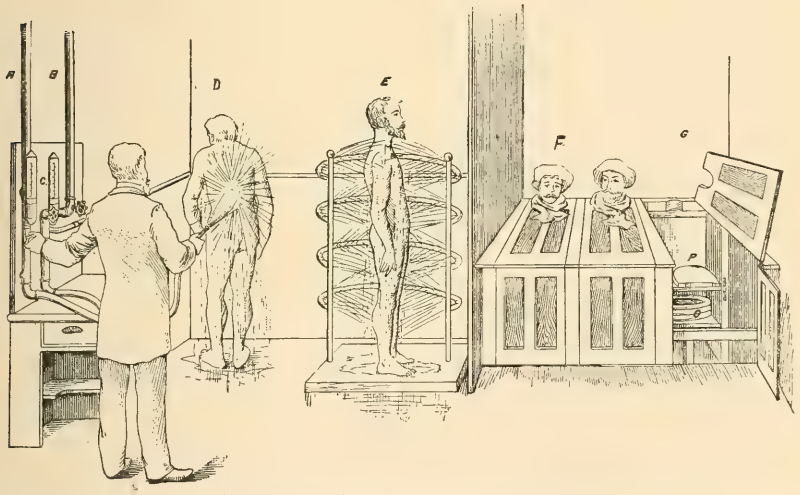
one to three atmospheres, which is equivalent to a fall of from thirty to ninety feet. The most useful arrangement is a fall of about seventy-five feet, with graduated pressures produced by side-outlets or pipes leading from separated reservoirs.

The mode of delivery of the water has furnished certain appellations. The *shower-bath* is one familiar form of the douche. This may be delivered also from a nozzle with numerous perforations which may be attached to a hose, striking the body in a divided stream. Its effect is different from that of the simple douche, called the *jet douche*, which issues from a stationary pipe three feet from the bather or from a nozzle attached to a hose, which is better, and called the *douche mobile*.

The *fan douche* is made by placing a piece of movable copper plate, or simply the finger, over the stream issuing from the nozzle. This spreads the stream like a fan, and when delivered under three or four atmospheres its stings render it difficult to recognize the lowest temperature of the water.

The *rain-douche* consists of from four to six three-fourth circles of pipes secured together at a distance of two to three inches. Each pipe has three lines of fine perforations, from which the stream issues under

FIG. 76.



Author's Douche-room at Montefiore Home.

D, Jet Douche. *E*, Rain-Bath. *F*, Hot-Air Bath. *G*, Hot-Air Bath open, showing *O*, Steam Coil under Seat, *P*.

pressure, striking the body of the patient, standing within it, at all points with considerable force. This is a favorite bath with me at the Montefiore Home as a substitute for the dripping sheet, because large numbers can thus receive treatment rapidly.

Each one of these modifications of the douche requires certain points in the technique which are essential. That *the temperature*

of the water must be exact goes without saying. In order to obtain this with precision a thermometer must be secured to the pipes in such a manner that the temperature may be read off before the water is turned upon the patient. The arrangement which is depicted in Fig. 76, which was designed by the writer for the Montefiore Home and has been in use there for several years, explains itself. The pipes are one inch in diameter, nickel-plated, and are connected with the main hot- and cold-water supply. *A* is the hot- and *B* the cold-water pipe. Being connected by *C*, the hot and cold water may be mingled until the requisite degree is indicated on the thermometer, whose bulbs are in contact with the water. As the douche rarely lasts over a few seconds, the change in the temperature of the water during its outflow will not be material.

The *duration of the cold douche* is a matter of importance. It should always be brief, not exceeding three minutes, usually from ten to seventy-five seconds.

The impression required is evanescent. The douche combines more than any other procedure the pronounced mechanical and thermic elements. Inasmuch as the application is made over various parts of the body successively, it resembles the ablutions or partial baths, but the mechanical effect is more intense. The latter, if combined with a low temperature, produces *hyperæsthesia* of the cutaneous surface, unless it is prolonged beyond one or two seconds, when *anæsthesia* may result. Winternitz found an increase in muscular power, as measured by the dynamometer, and an enhancement of electro-motor excitability, as evinced by the susceptibility to electric influences in paretic muscles only partly obedient to the will. Upon the body-temperature the effect is not pronounced, but upon the blood-pressure, vascular tone, and circulation the effect is the same, only intensified, as other hydriatic procedures. When a douche apparatus is not convenient, the practitioner may accomplish analogous results by allowing the patient to stand in twelve inches of water at 95° and forcibly pouring basins of water over the shoulders and body. It is well to begin all douches and affusions with a temperature of 95°, and reduce them daily one or two degrees, until the patient's tolerance is ascertained.

Therapeutic Indications.—The douche is chiefly applicable in chronic disease demanding a powerful nerve-stimulus. In paræsthesia and paralysis of hysteria, in all conditions of loss of tone in which no organic defect exists in the nerve-centres or their conducting lines, brief douches of water from 60° to 40° are useful. For hysterical convulsions there is one sovereign remedy—cold water, either in a bath or douche, says Strümpell. But as a general tonic the douche is found serviceable in all forms of hysteria in the Montefiore Home.

In anæmia, chlorosis, and other blood-diseases due to disturbed

tissue-metamorphosis the douche will prove advantageous for arousing the dormant nutritive energies. I have seen the hæmoglobin percentage raised in four months from 45 to 100 in a case of chlorosis that had been vainly treated by four physicians with iron, diet, change of air, massage, etc.

In *neurasthenia* there is no one therapeutic method so useful.

Extraordinary effects are recorded also upon enlargements of the spleen and liver. Delmas reports actual measurements by Piorry, before and after the douche, applied to the spleen, in evidence of the possibility of moderate reduction of its size by this procedure. In inveterate cases the method should by no means be neglected.

In *chronic inflammatory conditions* on or near the surface the douche may often be resorted to with great advantage, especially in the form of the Scotch douche, which consists of alternate streams of hot and cold water rapidly and briefly applied.

In *chronic rheumatic arthritis* more may be accomplished by this method than by any other local treatment.

In *obstinate neuralgic diseases*, intercostal and trigeminal and articular, the French writers report remarkable results from general douching. Delmas and Duval furnish clinical histories of the most inveterate neuralgias in which, after gradually accustoming the patients to bearing cold water by ablutions, they utilized the douche of one quarter to one minute's duration, of a temperature from 37° to 45° F., promenaded, as they aptly call it, over the entire body, once or twice a day. These histories must be read to be appreciated, that the reader may be imbued with the value of hydrotherapy in these as in other obstinate neuroses.

In this brief *résumé* it must suffice to say that I have had occasion several times to follow the methodical treatment recommended by Duval, with results that border on the marvellous.

In *dyspepsia*, Germain Sée, Ziemssen, and others refer to the importance of douches and other hydrotherapeutic measures. Germain Sée justly claims that, inasmuch as Mosler's vivisected animals showed contraction of the muscular coats of the stomach and intestines, and also diminutions of the spleen, under douches applied to the surface, this method must be useful in atonic states of the muscular and mucous coats of the stomach. Hydrotherapy is called upon to fulfil the most valuable indications in dyspepsia. It stands at the head of the means for combating atrophy of the abdominal muscles, and attacks the root of all troubles of the motor innervation producing dyspepsia. Thermic agents in general, and cold in particular, are powerful modifying agents of motor innervation. After considering the general effects of cold baths, he says it will be necessary to use a cold application of certain duration to the abdomen, made in the intervals of digestion,

combined with sedative douches to the vertebral column to diminish morbid excitability of the spinal axis. To stimulate the languishing contractility of the abdominal muscles recourse should be had to rain or fan douches directed on the stomach, or, what is better, to the "Scotch douche." My personal observations are that the general tonic effect is really the more valuable, and that most local applications of cold owe their efficacy to the principles explained in the preceding pages.

These douches modify the circulation of the intestinal mucous membrane, the insufficient secretion of the glandular apparatus, the lack of acidity of gastric juice, and the excessive production of mucus, as well as the general nutrition.

We possess in cold water applied to the skin a powerful means of regulating the action of the heart by augmenting the sum of its useful work. Klemperer, of Leyden's clinic, reports the most favorable results.

Peripheral excitation of cutaneous nerves acts reflexly upon the pneumogastric and excites the terminal ends of the splanchnic nerve, causing contraction of the vessels controlled by these nerves. Thus a more active and healthful circulation is produced in the chylopoietic viscera.

For *obesity* we possess in cold douches, properly applied in connection with vapor-baths, as shown by Godlewsky and Anton Frey, a most powerful agent for producing metamorphosis of fatty tissue. The ordinary method of gradually lowering the temperature of the douche, adopted in Turkish and Russian bath establishments, defeats the physiological action above referred to as resulting from intense thermic impressions, and are therefore as absurd as many other hydriatic procedures practised by uneducated people. Unfortunately, physicians do not attach sufficient importance to the absurdity of these Turkish-bath practices, which delude corpulent people into a belief that they are benefited because the scales show a reduction after the bath.

Improved tissue-metabolism, especially the consumption of more nitrogenous tissue-material, results from *pronounced* thermic impressions alone. Hence the douche following the vapor-bath, if it is applied for the purpose of fat-reduction, should be in decided contrast with the temperature of the skin. A temperature not above 70° should be tried the first time for one minute. This should entirely cease for five minutes, to allow the patient to react. Now a douche of 60° may be tried if the pressure is over one atmosphere. Five minutes should again elapse ere the third douche is given, and this should only be given to vigorous people. If full reaction has occurred, the last douche may be given at 50°, or even 40° F. No harm will ensue from the latter temperature if the stream comes in a spray under great pressure, say three atmospheres (ninety feet descent). Having thus ascertained the patient's reactive capacity, a lower temperature may be begun with

each vapor-bath. The reported results are very satisfactory. But this treatment should never be undertaken by the lay attendant without medical supervision and cautious adaptation. The highest and lowest contrasting temperatures which the patient is capable of bearing without detriment are the most efficacious in removing an excess of fat. This is a principle established by physiological experiment and corroborated by clinical experience.

To sum up; the *douche* is adapted to the most varied conditions and is capable of fulfilling every function of a hydrotherapeutic procedure. According to its temperature, form, duration, and atmospheric pressure, we may abstract heat, produce contraction and dilatation of blood-vessels, slow the action of the heart and improve its force, deepen the respiration, send the blood to parts formerly sluggishly vascularized, and draw it from hyperæmic portions, excite nerve-influence of various degrees, produce change in functions, secretion, and tissue-changes. Our French confrères regard the *douche mobile* as the therapeutic arm of the physician, and place it at the head of all other procedures. We must not lose sight of the fact, however, that the douche, as in all procedures, is but one part in the scheme of therapy. We must not accept the statement of enthusiasts, who would have us accept it as a veritable panacea in all ills.

The Sitz Bath.—These baths are administered in tubs arranged for this purpose, and made of wood or zinc, so that the patient may sit comfortably in them, while the feet repose outside upon a raised surface and blanket, so that the popliteal spaces are not encroached upon by the edge of the tub. The water should reach the umbilicus. The cold sitz bath (60° to 75° F.) has been frequently the subject of investigation. Heat is abstracted, the respiration is deepened and slowed, and the heart acts more forcibly and slowly under its influence. Weisflug[1] observed a slight rise of temperature from cold sitz baths in the normal conditions, while in fevers no diminution could be noticed. After the bath the pulse became softer and slower and the temperature fell. In fevers each bath was *succeeded* by an increased fall of temperature.

The first effect of a cold sitz bath is a feeling of oppression in the head, sometimes resulting in vertigo; the cerebral and facial vessels are congested; there is dyspnœa, followed by a deeper respiration. The volume of the other parts of the body is increased, as Winternitz has shown with his pletysmograph on the arm. The blood thus brought to the surface must come from the viscera, to which, if the bath is brief, it returns at once; if prolonged, there results a veritable diminution of blood in the abdominal organs. This has been demonstrated by Winternitz, who has also pointed out the fact that the intra-abdominal vessels form a reservoir which receives and gives off blood, perhaps to an

[1] *Archiv. f. klin. Med.*, 1886.

even greater extent than the cutaneous vessels. Their capacity for change is a safety-valve for regulating the blood-pressure of the entire body.

Golz's "tapping experiment" demonstrates how the mesenteric vessels of a frog were filled when the blood was driven from the surface. The phenomena produced when the lower part of the human body is placed in a tub of cold water can only be explained by the devascularization of the internal vessels, chiefly those of the abdomen and pelvis.

A reflex excitation of the sympathetic plexus is probably the chief agency in this effect upon the blood-vessels. The axillary temperature is also raised during the first portion of a sitz bath, due to the increased flow of blood to the upper part of the body.

Therapeutic Indications.—The narrowing of the intra-abdominal vessels would naturally produce change of function in the organs supplied by them. Hence we have here an excellent method of treating the most obstinate cases of diarrhœa, in sitz baths of 54° to 60° of half an hour's to one hour's duration, or longer with care, preceded by a good wet sheet rubbing to dilate the cutaneous vessels and thus aid the derivative effect. In cholera the most striking results have been reported by Medical Director Vogl, of the Bavarian Army. He orders the rectal and axillary temperatures taken; then the patient is wrapped in a cold wet sheet and thoroughly rubbed until he warms up. He is now wrapped in a warm blanklet and put into a sitz bath at 50°, in which the uncovered pelvic parts are rubbed continuously by two attendants for fifteen minutes. He is now put to bed with an abdominal compress wrung out of water at 50°. After this procedure perspiration ensues. Vogl gives no opium. Winternitz and other authorities sanction this cold treatment by their favorable experiences. In menorrhagia, subinvolution of the uterus, and pelvic cellulitis these baths are exceedingly useful, inasmuch as they reduce local temperature, diminish hyperæmia, increase the tone of the muscular fibre and that of the coats of the pelvic vessels, and enhance local tissue-changes.

Insolation is a disease in which cold has been applied so indiscriminately and with such difference of its physiological effect that a word of warning may not be out of place. Cold, and especially ice, should never be applied for the purpose of reducing the high temperature of this disease. The latter is but an expression of the disturbance of the heart-regulation by the disease-producing agent. The chief aims of treatment should therefore be to stimulate the depreciated nerve-centres. For this purpose we have in cold applied with friction and with the aid of reaction always a remedy of unsurpassed value. The following statistics from an epidemic in 1896

prove the correctness of this view better than any theoretic argumentation:[1]

	Mortality.
1. Graduated bath (110° to 79°, 15 to 20 minutes)	41.7 per cent.
2. Ice-pack	38.7 "
3. Cold baths (50° to 75°, 10 minutes or more)	11.5 "
4. Affusions with force of ice water, which was stopped when the body temperature reached 103° (O'Dwyer practice)	6.0 "

The above demonstrates that a change from the antithermic procedures (ice-baths, ice-packs) to the real nerve-stimulating procedures (douches and affusions) have reduced the mortality just as they have in typhoid fever.

In obstinate amenorrhœa dependent upon local anæmia, as is mostly the case, brief sitz baths of from 40° to 50° for eight or ten minutes, with friction, and repeated twice a day, are useful as driving blood to the pelvic vessels, and by reaction withdrawing it again to the surface.

In a depressed condition of the sexual function of the male the same treatment is useful. Care, however, should be exercised in seminal emissions to ascertain the cause, if possible, since many cases of hyperæsthesia would be aggravated by these cold baths, while warm or more temperate baths would be useful. Warm sitz baths are useful as agents to diminish the activity of the cerebral circulation.

In acute and subacute amenorrhœa, cystitis, intestinal and vesical tenesmus, prolonged baths of from 90° to 100° are valuable remedies. In chronic metritis, subinvolution, and all troubles accompanied by bearing-down and lumbar pains a graduated sitz bath has been with me among my most useful procedures for twenty-five years. It is best taken before retiring. The patient seats herself in a hip-tub containing water at 95°, to which she adds slowly (without touching the body) cold water (less than 50°) until she feels chilly. Upon rising she dries the skin and practises thorough friction. Many other uses of the hot and cold sitz baths will suggest themselves to the practitioner who understands their *rationale*.

In phthisis various cold procedures, gently begun and judiciously advanced, are of great benefit in stimulating nutrition and improving hæmatosis.

The Use of Water in Cavities of the Body.

This is a special branch of hydrotherapy which has been developed within the last two decades into an important one.

Stomach Irrigation.—To Leube and Kussmaul we are indebted for the popularization of stomach irrigation, which for diagnostic and

[1] *The Principles and Practice of Hydrotherapy*, by Simon Baruch, p. 322.

therapeutic purposes I have found of immense value. The technique consists of introducing one-third of a soft but firm rubber tube, sixty inches long and of a diameter of half an inch, into the stomach, pouring warm water through a funnel connected with the tube into the stomach, and allowing it to run out by siphonage into a vessel. The end of the tube being held between the thumb and forefinger, it is pushed into the pharynx through the open mouth, while the patient is asked to swallow. Gagging results, but gentleness and calm persuasion overcome the patient's fear of choking. About a pint of water is poured in at once to avoid over-distension. It is well to protect the patient's clothing by a rubber or oilcloth sheet.

For diagnostic purposes about one and a half to two quarts of warm water, poured in five hours after a full meal, suffice. The water emitted will show what portions of the food are not digested, how much if any mucus is present, and the muscular power of the gastric walls will be tested by the readiness with which the stomach expels the water.

For therapeutic purposes the chief value of these irrigations is found in gastric catarrh with enfeebled muscular walls, which permit overdistension and lessen the motor-power of the stomach.

In some cases of hepatic colic from gall-stone, and even in cases of ileus, Rosenthal, Kussmaul, Senator, and others have applied stomach irrigation with so much success that this measure should always be tried before resorting to surgical means.

In the gastro-intestinal disturbances of infants Ebstein and Leo in Germany and Seibert in this country have obtained excellent results from stomach irrigation, which I can endorse from personal observation. It will remove all fermented and fermenting material from the stomach, and give a clean beginning, which aids in the digestion of sterilized milk.

Intestinal irrigation is another hydriatic procedure that is now commonly resorted to with great benefit.

In cholera enteroclysis has proved useful. This is a continuous irrigation of the intestines with a long tube, which delivers warm water for cleansing the entire large intestinal tract.

In catarrhal jaundice Krull has shown us how to cure cases rapidly by daily irrigating the bowels with water of from 60° to 75°, and I can testify to its value from personal experience. The effect is explicable upon the experiments of Bidder and Schmidt, Lehman, Roehrig, and others, who have clearly proved that the introduction of large quantities of water into the stomach and intestines produces a more decided increase of bile than the entrance of water into the blood.

In acute and subacute dysentery the removal of irritating matters and pathological products, added to the soothing effect of the warm

water, will do more to allay tenesmus and cure the disease than all other remedies combined.

In the obstinate intestinal catarrhs of infants and in acute summer diarrhœa I rely upon intestinal irrigation with warm alkaline water to bring relief in the most unpromising cases. Indeed, I view these alarming cases with indifference, since abstinence from milk food, and its sterilization later, together with stomach and intestinal irrigation and cool baths and compresses, have become my chief reliance.

The *hot vaginal* douche need only be referred to here as a hydriatic procedure of well-recognized therapeutic value. It should be applied with careful attention to the details established by its originator, Dr. T. A. Emmet, who, if he had made no other contribution to gynecology than this, has earned the lasting gratitude of suffering women. The flat douche-pan devised by Dr. H. T. Hanks, and the use of the Davidson or "alpha" syringe with large quantities of water at 110°, constitute the important technical trio.

In post-partum hæmorrhages there is no remedy equal to hot irrigation of the uterus, with proper provision for outflow from the cervix.

Surgical Asepsis, it may be claimed with justice, owes more to hydrotherapy than to all else for its efficiency. The irrigation of operative fields and wounds with warm water is far more valuable than antiseptics, as the profession is slowly beginning to appreciate.

Water-Drinking.

This is a therapeutic auxiliary which is too highly lauded and carried to an extreme by the hydropaths, and yet is too much neglected by the regular profession.

Glax has shown that the drinking of warm and cold water has an effect on the vasomotors analogous to its external application, and that the diuretic effect of water-drinking is not the result of the quantity imbibed, but of the irritant action of the cold, which increased the blood-supply of the kidney just as the external application does.

The drinking of hot water before meals has become quite a routine practice now. Here, again, precision is demanded to prevent failure. The water should be as hot as it can be borne, and drank at least an hour before each meal.

Drinking large quantities of water of different temperatures produces definite effects. Water of 60° or less in moderately large quantity reduces, according to Lehman, the pulse for about eleven minutes, and the rectal temperature falls.

The absorption of water from the gastric vessels depends upon their tension, being most rapid when the latter is low.

The idea that the imbibition of large quantities of water renders the blood more watery is erroneous. Boecker has clearly shown that this

is a very transient result, and that in half an hour the blood is really less watery than it was after twenty-four hours' abstention from water. It acts as a diuretic, not alone increasing the watery parts of the urine, but also the solids, especially the urea and the phosphates and sulphates. This would indicate an enhancement of retrograde metamorphosis of nitrogenous material. This is also confirmed by an increased carbonic-acid excretion and oxygen absorption when large quantities of cold water are consumed.

An interesting observation by Mosler is to be remembered as of practical value. He has found that the consumption of large quantities of water produces more decided effects upon women and children than upon male adults. Drinking large quantities of cold water increases peristaltic action, as evidenced by the expulsion of gases. The quantity of uric acid is also said to be decreased when water is drunk, and other secretions, as that of the parotid gland, are increased. Diaphoresis is certainly increased by copious water imbibition.

It follows, therefore, that the *therapeutic indications* for drinking water are found in all those diseases in which a rapid interchange of tissue-materials is desired, or in which elimination of pathological material is to be facilitated, or in which diaphoresis or diuresis is to be stimulated. Too little use is made of this important physiological modifier by the general practitioner.

Hot-air and Vapor-baths.

As auxiliary measures to hydrotherapy the so-called Turkish and Russian baths are often used.

The French constantly apply the hot-air baths by means of a box in which the patient is surrounded by hot air (furnished by a lamp), while his head is outside, as a preparatory measure for their douches. This is far superior for remedial purposes to the usual Turkish baths, in which the patient is compelled to inhale hot air, often rendered noxious by the enforced restriction of ventilation. At the Montefiore Home the boxes shown in Fig. 76, *F*, *G*, are supplied by a steam coil, which elevates the temperature of the air to 130°, and 150° if necessary. Very high temperatures are really not needed. My method is to be guided by the effect upon the patient's temperature, which may readily be taken in the mouth, and by his pulse. If the former is raised from one-half to one degree, and the skin is in active perspiration, and if the pulse is accelerated to over 120, the patient is removed and subjected to such hydriatic procedures as are indicated in the case.

The usual method of gradually reducing the temperature of the water is doubtless pleasant, and perhaps useful in health, but in disease

it neutralizes the reflex effect upon the peripheral nerves, as has been mentioned above.

The vapor or Russian bath may be produced also in the box bath by permitting steam from a pipe to permeate it, and providing for its escape.

The ordinary baths of this kind supplied in establishments are so familiar that it is unnecessary to describe them, as they abound in all places where they are used, and their modification by boxes or cloaks enables the practitioner to imitate them successfully even in the remotest rural districts.

The rationale of these baths has been dwelt upon already. They raise the temperature, increase the pulse and respiration, and enhance tissue-metamorphosis. They are therefore invaluable in rheumatic and gouty affections and in some cases of chronic nephritis and in obesity. In the latter the hot vapor-bath, followed by cold douches, is to-day the most useful auxiliary to diet and muscular exercise.

Sand- and Mud-baths.

The first of those is prepared by surrounding the body in a tub with a layer of dry warm sand which has been naturally or artificially heated. The temperatures usually applied are from 95° to 120°, and their duration one to one and a half hours. The head is wrapped in a wet towel and permitted to lie outside of the sand. After removal from the sand-bath the body is treated as after a hot-air bath. By this means the pulse and respiration are accelerated as in other warm baths, and profuse perspiration ensues.

The mud-bath is prepared by mixing well-seasoned earths, containing more or less mineral matter, with water containing the same substances, and surrounding the body with this mixture at various temperatures from 90° to 100°. After the mud-bath the patient is rinsed with warm water, and as a large quantity is required to cleanse him of the filthy mass, he really obtains a prolonged bath in addition.

Kisch claims he has ascertained sphygmographically that these baths elevate the tension of the vascular system more than the ordinary warm bath, and as they may be given at a much higher temperature, their effects are more decided.

The therapeutic indications for the use of sand- and mud-baths are various, and they may be given either partially or completely. They act as emollient or heat-enhancing procedures, according to their temperature.

In uterine diseases of indefinite character, not amenable to surgical treatment, mud-baths may be of value. It is difficult to understand how any mineral admixture can be expected to be useful, since it is a well-established fact that they are never absorbed through the uninjured

skin. Still, they have been found very useful in obstinate rheumatism and gout, and in Franzesbad for uterine disease. It is claimed by Kisch that the iron mud-baths cure enlargement of the spleen. How much the psychical element and subsequent douching contribute to the cure is still undecided. There is certainly sufficient demonstrated value in these baths to entitle them to a fair trial.

General Conclusions.

An unbiassed review of the physiological observations of the action of water explains at once the seeming paradoxical effects of hydriatic procedures upon the human body, and offers a rational warrant for the remarkable historic fact that amid all the vicissitudes of therapeutics water is the only remedy which has successfully resisted the prejudices of medical men and of the laity.

Hydrotherapy has maintained its position, not only on empirical grounds, but it is to-day more firmly entrenched in the minds of progressive medical men than it ever was before, simply because *it is based upon well-ascertained and exact physiological facts*, the application of which forms the most brilliant chapters of clinical medicine.

It is, however, far from the writer's intent to enter into a propaganda for hydrotherapy as an exclusive treatment of disease, and thus rank himself with those empirics, the hydropaths, who have done much to discredit the remedial value of water. He would stultify his entire record were he to announce his adhesion to so absurd a doctrine.

Aside from the valuable medicinal acquisitions of the past, modern research has given and is still giving us remedies whose exact and positive effects upon the system are startling, and must, when they are fully appreciated after the enthusiasm of novelty passes away, enrich our therapeutic armamentarium vastly. It does not detract from these to bring forward a plea for this ancient and well-tried friend of the physician, whose triumphs at the bedside have been recorded by some of the best and ablest exponents of medical science. I plead for a fair and impartial test of water as a therapeutic resource, based upon its historical record, its physiological rationale, and its clinical results.

Whosoever shall read the history of this therapeutic agent from the time of Hippocrates, and pass in review some of the men who from time to time warmly espoused its many-sided advantages, must conclude that its claim on this score commands our highest respect. Since the day of Priessnitz (who built up a stupendous empirical structure upon water as a sole remedy), however, medical men have stood aloof and permitted his followers to monopolize the valuable properties of this agent. Its revival was brought about by French physicians, who at that time did not look askance at German medicine, but even went

to the extreme of studying German empiricism. The celebrated French physician Scoutetten, who had been sent by Marshal Soult to Graefenberg, brought back a favorable report, which stimulated the adoption of hydrotherapy by French physicians, among whom it is at the present time much in vogue in acute and chronic diseases, chiefly in the treatment of the latter, as taught by Charcot and Dujardin-Beaumetz. It was not until 1861 that the Germans were again aroused to a realization of the remedial value of water by Ernst Brand. Niemeyer, Bartels, Juergensen, Hoffman of Leipzig, Vogl of Munich, Nothnagel, Fuerbringer, Erb in Germany, Semmola and Cantani in Italy, are names familiar to students of modern medicine which stand as vouchers for the good repute of hydrotherapy in recent times. One man stands above all others—Wilhelm Winternitz, to whom we owe nearly all we know of modern scientific hydrotherapy. In this essay his work has been so often utilized that it would be tiresome iteration to quote him again.

It is my aim to stimulate a revival of hydrotherapy, as far as lies in my power, by a plain, unvarnished exposition of its methods and results from the most reliable sources, but not to encourage its application as a sole remedy to supplant all approved medicinal or other agents.

The author has derived the opinion expressed in the résumé from the observation of over one hundred thousand procedures in private hospitals and dispensary practice.

To sum up the aims, capabilities, and results of hydrothorapy, it may be said—

1st. We possess in this method a valuable auxiliary to methodical treatment of many, though not all, acute and chronic maladies.

2d. In acute diseases its value is most demonstrable in the *early* stages of pyrexia, in which it will accomplish more than any other remedies; it may also be usefully applied in non-infectious diseases of short duration.

3d. In many chronic diseases it has proved so successful after failure of medicinal remedies that *no case should be yielded up as hopeless until hydrotherapy in some form has been tried.* My experience at the Montefiore Home, which receives only incurable cases, demonstrates this fact.

4th. Domestic treatment by the methods here indicated will suffice in most cases, but if these fail a methodical treatment under an expert hydrotherapeutist may be to the advantage of the patient.

The most important elements are the thorough mastering of the general principles of hydrotherapy, precision in their application, and their perfect adaption to the constitutional peculiarities of each case—*i. e. not treating the disease, but the patient.* For this reason the best

consultants in Germany, in Italy, and in France—men like Leyden, Charcot, Senator, Semmola, Ziemssen, Krafft-Ebing, Bernhardt, Mendel, Nothnagel, Binswanger, Erb, and Leube—send their patients to hydrotherapeutic establishments which are under the direction of educated physicians who have studied the subject, with their diagnosis and general suggestions, rather than with specific directions for the method to be employed. The same practice is rapidly gaining ground in this country. Unfortunately, such institutions under medical management exist in only a few cities. But several hospitals, especially for the insane and nervous people, have constructed hydrotherapeutic apparatus.

Finally, so much depends upon the reactive capacity of each patient that only systematic observations can determine the most useful hydriatic procedure in each case. For this reason this method should be taught in our schools, as is recommended by Kussmaul and Vierordt and Winternitz. Until such instructions become general the supervision of hydrotherapeutic institutions should always remain in the hands of educated physicians.

CLIMATE.

By S. EDWIN SOLLY, M. D.

THE object of the following article is to discuss the treatment of disease by climate, and not to give an exhaustive treatise on climatology, with a description of the several noted resorts and the diseases suitable for treatment in each; but rather to show the fundamental principles of the subject and the general bearing of admitted facts, which, if digested carefully beforehand or referred to when needed, will give to the general practitioner a rational basis for forming a judgment as to the kind of climate best suited to the patient upon whom he wishes to try the experiment of climatic change. The physician can then select from among the various places whose general characteristics range them in the class suitable for the case the one that from the more special information given in the handbooks appears to fulfil best the required conditions. Although it is desirable in a practical article on climatotherapy to avoid abstract questions and theories, it is nevertheless necessary, in order to reach the practical point sought for, to build up a pyramid as it were, the base being formed of physics, the next tier of physiology, upon which should be placed a layer of geographical pathology; then the main divisions of climates; above this their special divisions; upon this, again, a general description of the pathological conditions for the relief of which climatic treatment may be required—then the general therapeutical application; then the consideration of idiosyncrasy; and lastly, as its apex, the physician places his study of his individual case, and thus the practical point is rationally arrived at. As much of what is said under these various heads is familiar to many, each will be designated, so that when known they can be omitted in the reading and the conclusions earlier reached.

Climatology is the study of the characteristics of different portions of the earth's surface and of the effects of these characteristics upon man.

The word "climate" implies the physical characteristics of a given locality.

PHYSICS.

The elements which in their various modifying relations and proportions to one another constitute a climate are six—viz. Earth, Air, Water, Sunlight, Temperature, and Electricity.

For the sake of better studying the fundamental causes of the varied peculiarities and effects of climate, certain subdivisions of the six elements are presented; but it must be borne in mind that in nature they are so closely interlaced one with the other that many of the divisions made, though convenient, are more or less arbitrary.

The first climatic element of the six enumerated is earth. This admits of two chief subdivisions—viz. composition and configuration, its composition ranging under two subdivisions—viz. soil and vegetation, and these being again divided as shown below:

EARTH.

- **Composition.—**
  - Soil
    - Rock,
    - Garden soil,
    - Clay,
    - Sand and gravel.
  - Vegetation
    - Trees,
    - Grass,
    - Plants.
- **Configuration.—**
  - Plains,
  - Mountains,
  - Valleys.

AIR.

Composition.—Nitrogen, oxygen, and argon, loosely combined, accompanied by watery vapor, ozone, electricity, carbonic acid, and more or less of germs, other gases, dust, etc.

Position.—Latitude—that is, distance from the equator (temperature decreasing and barometric pressure increasing from the equator to latitude 30°, and then generally decreasing toward the poles.

Altitude.—Height above sea-level (barometric pressure decreasing whilst rising from the sea-level).

Distance from the Ocean.—Giving divisions into—

- Sea air
  - Ocean air,
  - Shore air,
  - Island air.
- Inland air
  - Plain air,
  - Mountain air,
  - Valley air.

- **Mobility.—**
  - Wind,
  - Calm.

Water.

Composition.—Hydrogen and oxygen chemically combined, accompanied by more or less salts and frequently vegetable and animal impurities.

Localized Water.—As in seas, lakes, streams, and springs.

Mobilized Water.—As in rain, snow, hail, and dew.

Vaporized Water.—As in clouds, mists, fogs, and the watery vapor of the atmosphere.

Absorbed Water.—As present in solid bodies, soils, rocks, and vegetation.

Sunlight.

Light.—
- Daylight
  - Sunshine,
  - Shade.
- Night
  - Darkness,
  - Moon- and star-light.

Temperature.

Cold, Heat.

Electricity.

Constant.—
- Negative on the earth's surface,
- Positive in atmosphere.

Inconstant.—
- Thunder-storms,
- Electric disturbances.

The Earth.

Soil.—The temperature and humidity of the stratum of air lying immediately over it is modified by the intrinsic qualities of the soil. These qualities vary greatly. Dry clay can absorb its own weight of water, dry garden soil about one-half, and dry sand about a third. Sand dries most quickly, garden soil less so, but more quickly than clay. Sand is most readily heated, but cools equally fast. The temperature of the soil is usually about the same as that of the air above it.

The humidity of the soil has a marked effect upon the prevalence of certain diseases, notably phthisis and rheumatism, and this is why a situation over a sandy or gravelly soil is preferable for residence. On clay the humidity is retained for a time, and then given back to the air above it; but on sand or gravel it sipes through or runs off.

Vegetation has a considerable modifying influence upon climate, for where the vegetation is luxuriant there is an increased humidity of the air and soil; and this without necessarily greater precipitation.

The deciduous trees give off and require more moisture, and thus increase the humidity far more than the evergreens, which grow mostly on a light soil and thrive with less moisture. Evergreens are thought also to be beneficial from their exhalations of antiseptic resinous vapors. Arable land with growing crops is usually more humid than meadow-land, and it is believed that the increased growing of crops brings increased rainfall, though this is not established.

Plains are exposed to uninterrupted sweeps of the wind, as seen in the cyclones and blizzards which prevail on the prairies of the Western States. When wide plains are dry they are heated and cooled equally, and when no side wind blows the cooled layer of air remains upon the ground, and therefore the difference between day and night is very marked.

Where plains lie near mountains, owing to the proximity of the latter there are certain modifying protections from storms. "Clouds form quickly in the cooled air around mountains, and, remaining for the most part stationary around the peaks, diminish radiation, and so lessen extremes; damp winds, however, bring clouds which, instead of rising and hanging on the peaks, tend to blow across the slopes and valleys, and so produce rain and snow and lowering of temperature upon the windward side of the mountain, while the other, or lee side, is warmer and drier."[1]

Valleys.—"The climate of valleys varies very much with the way in which they are sheltered from cold and damp winds and are open toward the sun; the sides during sunshine increase the heat by radiation, and also diminish it at night. Therefore the extremes between day and night are more marked, while those between summer and winter days are not. The question of how much the sides cut short the hours of sunshine is important. These extremes of temperature when humidity is present give rise to mists and fogs in the valleys, while the upper slopes may be in sunshine."[2]

"*Aspect*—that is, the position toward the sun and wind—makes a great difference to a place, whether it lies on the sunny or shady side of a range, the sunny side in the northern hemisphere being the slope looking to the south-east or south-west. Besides the influence of the mountains upon winds as described, there is also a considerable effect from winds blowing over glaciers and snow-fields, bringing cold and, when melting, dampness."[3]

[1] "Klimatotherapie," von Dr. Hermann Weber, *Handbuch der Allegemeinen Therapie*, Leipzig, verlag von F. C. W. Vogel, 1880. This able and comprehensive work is the best treatise written upon climate, and I have availed myself largely of the information therein contained, and for the most part followed Weber's plan of classification of the various branches of the subject.

[2] *Handbook of Climatology*, p. 25, by S. E. Solly, M. D. Lea Bros. & Co. [3] *Ibid.*

The Air.

The air is certainly the most important element of climate, being the chief supporter of life and carrying with it most of the other elements.

Purity.—Angus Smith writes, very truly, that we are much more particular about a change in the water we drink than in the air, although we take in a far greater quantity of air than we do water, which, moreover, is modified by cooking food, etc.

Oxygen and Carbonic Acid.—The amount of oxygen relatively varies but slightly in a given weight of air, being only a matter of decimals. A very moderate excess of carbonic acid or a slight diminution of the amount of oxygen in the air we breathe exerts a marked influence upon us.

Ozone—allotropic oxygen—is a powerful disinfectant, more so than ordinary oxygen, though as 1 part of ozone in 700,000 of atmospheric air is about as much as is ever found, its direct action through the atmosphere must be insignificant. Ozone, however, is absent where injurious decomposition is going on, as in sick chambers, and is least in towns and greatest on the sea and mountains and under pine woods. It is increased by thunder-storms and intense sunlight.

Dust, Germs, and other Foreign Bodies.—One of the chief reasons for the climatic benefits of sea- and mountain-air is the absence of poisonous or irritating substances floating on it.

Latitude—"that is, the relative distance of a given resort from the equator—largely influences a climate, both because the temperature declines with distance from the equator (more rapidly in the northern than in the southern hemisphere), and because of the variation in the density of the atmosphere—that is, the barometric pressure. In consequence of the heating of the air at the equator it expands, and thus, becoming lighter, it is raised into the upper region and flows toward the poles, where, being cooled, it again contracts and becomes heavier, sinks, and moves from the poles toward the equator, to be once more warmed and mount upward. Thus, there are always two constant, steady currents of cool air flowing over the earth's surface from the poles toward the equator—one from the north pole and one from the south. Both are modified by certain causes, which will be spoken of later." [1]

Altitude.—The pressure continuously diminishes with the height, because the column of air above an elevated place weighs less than that at the level of the sea. The lower layers of air are much heavier than the higher, so that the air at sea-level is 1.6 times as dense as that at

[1] *Handbook of Medical Climatology*, p. 26.

Potosi, which is 13,000 feet above it. In the same locality the variations are partly periodical and partly unperiodical or accidental.

Distance from the Ocean.—Starting from the ocean itself and gradually going inland till we reach the centre of a continent, we find modifications of climate occurring which are dependent chiefly upon two main causes—the lessened humidity, owing to the distance from the evaporation from the ocean, and lessened density of the air, owing to the rise in the height of the land.

There are of course modifying local causes, as where great lakes or inland seas intervene, or the land, instead of following the general tendency toward elevation, is depressed.

Currents and Winds.—The general direction of the winds passing immediately over the earth's surface is southerly in the northern hemisphere and northerly in the southern hemisphere, while the upper currents travel in the opposite direction for the reasons just given. More or less obliquity is given to the winds by the earth's rotation. The changing position of the earth to the sun at varying seasons and the difference in convection and conduction over sea and land cause further modifications. Mountain ranges, wide seas, and special local conditions may also serve to divert the winds from their main direction. Some of the local diurnal variations of winds call for at least brief consideration.

Sea and Land Breezes.—On the sea-coasts the usual daily sea and land breezes are accounted for in this manner: During the day the layers of air immediately covering the land become hotter than those over the sea. They rise into the upper air and flow away, and the heavier and colder layer over the sea comes in to take their place, thus producing the sea breeze, which is usually at its height in the early afternoon. After sunset, the radiation from the earth being greater than that from the sea, the layer of air over the land becomes heavier, and the sea layer, being lighter, flows away, and the breeze blows off the land to fill the void it tends to make.

Mountain and Valley Winds.—During the day the soil and lower walls of the valleys are strongly heated; consequently, the lowest layers of air in the valleys begin to rise along the mountain-slopes, radiating more rapidly than the bottom and sides of the valleys; the cold air descends with more or less force as the evening wind. For this reason places on the mountain-sides are often warmer in the evening and night than those lower in the valley. This consideration is often of consequence as regards the value of a particular valley as a health-resort, and further with respect to special houses or hotels in it. When there is a heavy rain- or snowfall or melting snows, these breezes, being damp, are apt to detract seriously from the otherwise good qualities of the resort.

The climatic influence of winds is very decided, as they may convey from afar to the resort to which they blow the humidity, temperature, and impurities of another climate, and thus in a degree transfer a climate to a different place. For this reason the foreign as well as the local winds of a resort should be studied.

WATER.

No water present in nature is absolutely pure, all containing more or less of salts, from the dense water of Salt Lake to rain-water, which is the nearest approach to distilled water that nature provides us with. Animal life is also more or less present, and vegetable and animal impurities are common.

Seas, Lakes, and Rivers, all have modifying influences on the climate, always increasing the humidity of the air, and generally the rainfall, and in the case of seas, large lakes, and wide rivers providing over their surfaces large spaces of fresh, uncontaminated air, and giving rise to daily breezes from and toward the water, owing to the difference in the radiation of heat between the land and water. These peculiarities are experienced more upon the surface of the ocean, lake, or river than upon the shore.

Humidity.—The watery vapor always present in a greater or less amount in the atmosphere is spoken of as the humidity of the air; this is of two kinds, absolute and relative.

Absolute Humidity is the absolute number of grains of vapor in a given quantity of air. When air is heated it expands, and so its capacity for holding vapor increases rapidly. A cubic foot of air at zero Fahrenheit can hold only 0.54 grain; at 32° F., 2.13 grains; at 50° F., 4.09 grains; at 80° F., 10.95 grains; and at 100° F., 19.79 grains.

Relative Humidity is the amount contained by the air relative to what it could contain, the standard maximum being 100 per cent. The lowest relative humidity, according to Humboldt, is 25 per cent.; under 55 per cent. is called very dry; under 75 moderate, to under 85 moderately damp; over which, very damp. Relative humidity is only of importance when the temperature is also considered, because warm air takes up more vapor than cold air.

Clouds have an important influence upon invalids, depriving them of the advantage of the sun, or beneficially mitigating its glare. Moreover, clouds, by radiating back the heat escaping from the earth's surface, may increase the warmth and equability of the air. Prolonged or frequent cloudy weather, while at first soothing, becomes depressing to the nervous system of delicate persons.

Rainfall is not synonymous with humidity, as very often the rainfall is very slight, yet the air is quite humid; for if there are no cold

currents the vapor in the air will not be precipitated in the form of rain. The Swiss hygrometric observations show that precipitation increases with elevation, with exceptions, as in the valley of the Engadine, where the mountains give shelter from the north and west. But in North America, as a rule, the reverse is true. In North America the rainfall increases from north to south on the Atlantic, and from south to north on the Pacific Coasts. The general rule is that the rainfall diminishes with increased distance from the sea-coast. The amount of rainfall and number of rainy days by no means necessarily agree, as in some places, where the rain is never moderate, there may fall in a few days more rain than is made up by a number of rainy days elsewhere. This point is of special importance as determining the number of days of outdoor life for the invalid. Speaking broadly, the number of rainy days increases from the tropics to the poles, while the amount of rainfall diminishes. With elevation up to a certain height the number of rainy days increase, above which they decrease. Rain is not necessarily prejudicial to invalids ; if not so frequent or excessive as to prevent a proper amount of exercise in the open air, it has the advantage of purifying the atmosphere, besides making it perhaps more vivifying by the formation of ozone and lessening of relative humidity, as people usually feel fresher and more active both during and after rain.

Snow.—The line of perpetual snow is lower going toward the poles, lower on the northern slopes of the mountains, and lower where the air is damp. Snow is not necessarily prejudicial to weak invalids, but frequent melting is of course bad. Covering of the ground with snow is often attended with advantage, as it prevents the formation of spores; snow on a clay soil, however, is always bad for invalids.

The evaporative power of the air of a place is important, especially in modifying the effects of rain ; it is variable, depending upon the temperature, relative humidity, density, and rate of motion of the air. It is by this evaporative power, or thirstiness, that the air is kept continually supplied with moisture, which is essential to organic life on the earth's surface.

Sun.

Light hinders the development of bacteria and other low organisms, and increases oxidation. Sunlight is more intense, of course, in dry air, and more prolonged in high latitudes in the summer, and *vice versâ* in the winter ; and this point has to be considered in regard to mountain-valleys.

Dry and Moist Climates.

"In classifying climates as dry and moist it is important to notice whether absolute or relative humidity is intended, and this must often be inferred from the connection in which the words are employed. Relative humidity is important in respect to the liability of the formation of fogs and dew, while physiologically the absolute humidity has often a greater significance. When statistics of relative humidity alone are given it is necessary to take some standard temperature to make a fair comparison. Wendt computes the mean annual temperature of the United States as 55° F., which is probably nearly correct. Assuming, then, a standard temperature of 55° F., we can say that less than 50 per cent. of relative humidity is *dry;* from 65 to 75 per cent. is *medium;* from 75 to 85 per cent. is *moist;* and above 85 per cent. is *very moist.*

"The importance of the temperature should never be forgotten in estimating the value of the relative humidity. For instance, on an ordinary sunny day in winter with the shade-temperature at noon at 40° F., we should consider under 70 per cent. of relative humidity as *very dry;* from 70 to 80 per cent., *dry;* from 80 to 90 per cent., *moist;* and above 90 per cent., *very moist.* On the other hand, on a day in summer when the shade temperature at noon is 70° F., we find less than 30 per cent. of relative humidity at that temperature is *very dry;* from 30 to 40 per cent. is *dry;* from 40 to 50 per cent. is *medium;* from 50 to 70 per cent. is *moist;* and over 70 per cent. is *very moist.*"[1]

Electricity.

The atmosphere is charged with positive, the earth with negative, electricity. Becquerel and Breschet have demonstrated that at altitudes under a clear sky the positive electricity in the air is increased. The temperature being lower also adds to this effect, and it doubtless has much to do with the feeling of exhilaration which is usually experienced at medium elevations. Thunder-storms are more frequent between 3500 and 6500 feet above sea-level than at greater or lesser altitudes.

PHYSIOLOGY.

Heat causes less food to be needed, increases the growth, but lessens the muscular force. Dampness increases the depressing effects of heat.

Cold causes more carbonic acid to be given off and more waste of substance, does not increase growth, but inclines toward its preservation,

[1] *Handbook of Climatology*, pp. 33, 34.

while increasing muscular power. As evidence of how mistaken is the usual dread of cold, mortality diminishes from the equator to the poles.

Increased Barometric Pressure.—The experiments of Vivenot, Lange, Paum, and G. von Liebig show that by an addition of one-half to two atmospheres the lung-capacity is increased, the number of inspirations and beats of the pulse are decreased, while the pulse becomes stronger; more oxygen is absorbed by the blood and more carbonic acid given off; and the appetite and assimilation are improved.

"When the pressure of two or three additional atmospheres is suddenly removed, as has been the case with workmen returning from labor in caissons and deep mines, the following effects have been observed: vertigo, nausea, pains in the joints and ears, even paresis, which is most cases was temporary, but in some fatal. In one of these an autopsy showed peculiar lesions of the spinal cord, which appeared as if grooved and torn.

"When atmospheric air is compressed the oxygen-tension is increased. In experiments upon animals placed in chambers containing compressed air it was found that there was a slight lessening of the rate of respiration, and, if the pressure was very high, convulsions arose and death ensued from asphyxia. This was due to retention in the blood of carbon dioxide, which could not escape owing to the great air-pressure, although there was a superabundance of oxygen to be absorbed. As might be expected, the effects of compressed air are exactly contrary to the effects of reduced barometric pressure as exhibited under bell-glasses or in high altitudes. These experiments did not cause any of the peculiar nervous effects arising in some persons after leaving caissons in which they had been working; which symptoms are chiefly due to congestion and frequently to degeneration of the lower half of the spinal cord. Autopsies have revealed congested areas with spots of degeneration, even rents in the tissue, escaping bubbles of gas (asserted by Paul Bert to be nitrogen), black blood, etc. During life various paralyses were observed. It is probable, as stated by Andrew Smith and also by Gilman Thompson, that the cause of these nervous phenomena is the exhausting nature of the work in the caissons, followed by too sudden a change back into ordinary air."[1]

Dr. Theodore Williams, writing upon the effects of compressed air, after detailing some of his experiments with the compressed-air bath, says: "Compressed air exercises an intropulsive influence on the circulation, affecting those surfaces most exposed to it, such as the skin and lungs. The blood is thus drawn into the organs protected from air-pressure, namely, the brain, heart, liver, kidneys, and

[1] *Handbood of Medical Climatology*, p. 40.

spleen. The pressure is exerted more on the capillaries and superficial veins than on the deeper veins and arteries, and its tendency would be to reduce pressure in the right side of the heart and to increase it on the left. Dr. Burdon Sanderson thus accounts for the slower pulse-rate: 'The effect of the diminished fulness of the venous system is to retard the filling of the ventricles during the period of relaxation, and consequently to lengthen the diastolic period and thus diminish the frequency of the pulse.'

"The introduction of a larger amount of oxygen causes greater absorption by the lungs and leads to further oxidation and tissue-change; this being proved by the bright color of the blood seen during bleedings in the bath, by the increase of carbonic acid exhaled from the lungs and of urea excreted by the kidneys. Muscular power is augmented, appetite generally improves, and weight is almost invariably gained. The temperature is not materially affected."[1]

In the few resorts in places below sea-level are the rare and moderate examples which exhibit the climatic phenomena of increased atmospheric pressure.

Decreased Barometric Pressure.—Its physiological effects, as might be expected, are for the most part directly opposite to those of increased barometric pressure when the animal experimented upon is kept for a month or more under a low pressure the immediate and permanent effects are found to differ in certain respects. The immediate effects as observed upon men and animals experimented upon in laboratories and also when transported from sea-level to a high altitude are as follows: the pulse-rate is increased though somewhat diminished in strength and volume; the number of respirations is increased while their depth is decreased; the desire for food is often diminished, and nausea and disturbances of digestion are not infrequent. Headache, dizziness, and even hallucinations may occur; there may be also a slight rise of bodily temperature. All these symptoms are markedly increased upon exertion, which is undertaken with difficulty.

The following experiment of Paul Regnard confirms these facts: He placed two guinea-pigs under diminished barometeric pressure. One of them he forced to exert itself by placing it upon a treadmill. This animal soon succumbed; but the other, which was allowed to remain quiescent, was but little affected.

Under increased pressure the blood is driven toward the internal organs, leaving the skin pale with the cutaneous vessels empty, as shown in the ears of the rabbits experimented upon by von Vivenot. The exact opposite occurs under decreased pressure. When the

[1] Williams's *Aërotherapeutics*, p. 102.

decreased pressure is not excessive, after three or four weeks the animal accommodates itself to the changed pressure. The respiration returns to its normal rate, while its depth is increased beyond that under normal air-pressure; the pulse-rate becomes normal and its strength and volume markedly increased. The circulation is equalized and certain changes occur in the blood, the number of red cells, hæmoglobin, and specific gravity being markedly increased. These changes continue as long as the animal is under diminished pressure. After the pressure is reduced to that of sea-level the blood slowly returns to its normal condition. That a true blood regeneration takes place has been proved by examining blood taken simultaneously from the aorta and cutaneous vessels and the finding of the same conditions in each specimen. The causes of blood-changes is very reasonably ascribed to diminished oxygen pressure. Experiments have proved that when blood is exposed to air under diminished barometric pressure it can take up only a certain percentage of the oxygen present in the inspired air. In order to compensate for the deficiency of oxygen in the air under diminished pressure the animal makes an effort to take in air more frequently and in greater amounts at each breath, thus necessarily causing a greater and more rapid flow of blood to the lungs, so that in a given space of time a larger area of blood is brought in contact with the air breathed, thus a greater total amount of oxygen is absorbed to compensate for the deficiency in each single breath. As a result of this increased and continued activity of the heart and lungs they are both permanently increased in capacity and strength, provided the diminution of the air-pressure is not too extreme and the change too rapid, or the animal's condition of health defective. These changes have been found in laboratory experiments to be quite independent of the accompanying atmospheric conditions of humidity, heat, and light.

Geographical Distribution of Disease and Racial Distinctions.

We will now briefly discuss the general effects of climate in causing the peculiarities of the various races of man and the geographical distribution of disease, the latter being the classification of the diseases to which man is most prone in special localities.

Man, more than any other animal, can assimilate himself to various climates, bearing the change generally without harm, and frequently with benefit. This capacity is, however, as might be supposed, much more developed in the natives of temperate climates than in those of polar or tropical regions.

The physical and intellectual differences of the various branches of the human family are justly ascribed, I believe, to climatic influences,

although there are still a few who argue against this theory and believe the differences were originally impressed upon the species; in short, it is the old argument between evolution and design, in which the former has very much the best of it.

There are two facts which are prominent in the study of the effects of climate upon man in causing racial peculiarities. The first is, that commonly, if natives of one climate are domesticated in another and different climate, in the course of a few generations the descendants of these foreigners take on the racial peculiarities of the people among whom they are reared to such an extent as to submerge or modify the characteristics of their ancestors, so that it is generally difficult to distinguish them from the ordinary natives. The second is that a succession of ages has failed to impart to natives of other countries the peculiarities of the Ethiopian and Mongolian races among whom they have made their home; and this fact is an argument in favor of original conformation, though it may be only climatic effect extending over immense periods of time.

In discussing the influence of climate in causing peculiarities of race and disease, Dr. Copland[1] writes as follows: "It may be stated in general of the northern temperate zone that the inhabitants of its more southerly countries have made the earliest advances in civilization, and that those of its middle and more northerly climates have carried the useful arts and sciences to the highest perfection. Within the range of this zone man presents the greatest diversity of temperament, of constitution, and of mental endowment. Muscular frames, plethoric habits of body, and the sanguine temperament predominate among the natives of the more northerly of temperate climates, particularly as regards Europe and its western countries. Affections of the chest and respiratory organs, inflammations, fevers complicated with inflammations of the lungs or of the brain, and rheumatism, are the most prevalent diseases.

"Epidemics assume most frequently amongst them a phlogistic character, and vascular depletions are more required and better borne in the treatment of their maladies. Climates which are the most variable as to both the commencement and the course of the different seasons are, notwithstanding the many disadvantages imputed to them, the most favorable to the advancement of the various bodily and mental powers. The rapid and frequent vicissitudes of weather preclude, as respects the community generally, the regular adoption of means to guard the body against their operation; consequently, the frame becomes habituated to their operation, and thereby fortified against the injurious impressions which would be otherwise made by them. That

[1] *A Dictionary of Practical Medicine*, by James Copland, M. D., F. R. S., London, vol. i. p. 343.

countries thus circumstanced are benefited rather than injured by this state of weather and season is shown by the robust frames, the mental activity, and the longevity of their inhabitants. The physical and moral history of the British Isles, Denmark, Sweden, and the more continental districts of Western Europe demonstrate this fact. In the eastern countries of this quarter of the globe, as well as in Central Asia and in North America, the seasons being much more regular in their advent and in their course, measures are more regularly and uniformly adopted to moderate the extremes of temperature and the vicissitudes of weather; and these have in many instances the effect of enervating the frame, of promoting the extension or prevalence of disease, and of thereby diminishing the mean duration of human life. Of this description is the use of excessively warm clothing, and of stoves which overheat the air of the apartments without renewing it as rapidly as is often requisite to the wants of the economy.[1] Hence, whilst the external atmosphere is cold, dry, and invigorating to the healthy frame in a state of activity, the air indoors is close, warm, and depressing, the frequent alternation from the one to the other, or the constant residence in the latter, being injurious even to those in health and causing diseases of the thoracic and abdominal viscera.

"While the natives of northerly inland countries suffer more especially from the extremes of temperature and of season, and the circumstances which arise out of them, they are less exposed to those emanations which arise chiefly from the decomposition of vegetable and animal matter, and to those endemic sources of disease that produce so much suffering and mortality in low or level districts and in more southerly climates, where the atmosphere is moist and warm. The inhabitants of temperate countries considerably elevated above the level of the sea, and of mountainous places, are generally of a spare, firm, and muscular habit of body, and strongly formed, chiefly owing to their active and industrious modes of life and the pure and light state of the air they breathe. The irritable, sanguine, and nervous temperaments, and quick, irritable, and generous dispositions, predominate among them. Inflammatory, hæmorrhagic, and spasmodic diseases, particularly hæmoptysis, bronchitis, consumption, asthma, inflammations of the lungs and pleura, rheumatism, and disorders of the circulatory organs, are most common. Their females are more virtuous and prolific, and the mean duration of human life longer, than amongst the natives of lower districts and warmer climates.

Germ Diseases.—"We find that contagious diseases are naturally most prevalent in crowded districts, and that contagion may prove stronger than climatic influences; the latter may modify its mani-

[1] This applies with great force to the habitations of the average American citizen. —S. E. Solly.

festations and progress, but cannot always prevent them. This accounts for the fact that such diseases as scarlatina, measles, diphtheria, etc., are found in all climates; and it is also true, in a somewhat less degree, of tuberculosis, as will be shown later.

"However, as some germs grow more vigorously or solely in high temperatures, for instance, those of yellow fever, and some more vigorously in low temperatures, as those of smallpox, climate does modify many of the germ-diseases. The degree of humidity in the air has also an influence on germ-life, but not nearly as much as the amount of moisture in the soil. This is notably the case with the germs of malaria, and in sending patients to damp climates the condition of the soil with respect to its moisture must be particularly inquired into. Speaking broadly, it may be said that germ-diseases are more active in hot than in cold climates, and in damp than in dry ones.

"Some germ-diseases are contagious, some spread only by infection through the air, some only through water and food, and some in all these ways, as does malaria.

DEATH-RATES PER 1000 DEATHS FROM ALL CAUSES.[1]

	Periods.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria.	Diphtheria and Croup.	Whooping-Cough.	Enteric Fever.	Pneumonia.	Consumption.	Diarrhœal Diseases.	Cancer.	Childbirth.
England and Wales	1880–89	2.5	23.1	19.6	8.1	15.3	23.6	10.6	53.6	90.9	39.5	29.8	7.8
Ireland	1880–89	0.7	10.7	13.8	3.8	14.6	12.8	9.1	29.4	115.8	18.1	21.8	9.3
Scotland	1880–89	0.2	18.9	16.9	10.9	21.9	31.1	12.8	54.0	104.7	25.6	29.6	9.1
Belgium	1880–87	15.7	25.1	12.4	. . .	21.1	32.8	26.1	. . .	. . .	73.6	. . .	11.2
Sweden	1880–89	1.0	11.0	30.3	34.1	42.3	12.7	15.2	. . .	. . .	25.4	. . .	6.8
Prussia	1880–89	0.6	16.7	18.3	. . .	65.7	20.8	15.4	56.5	122.6	41.8	14.4	8.4
Austria	1877–86	19.9	16.4	20.0	. . .	58.7	35.7	23.4	. . .	126.0	. . .	13.9	. . .
Saxony	1881–90	0.3	9.4	13.8	. . .	55.0	9.9	7.7	. . .	85.7	. . .	26.3	. . .
Norway	1880–89	. . .	6.3	21.8	33.0	. . .	10.4	6.4	46.5	82.7	. . .	29.7	12.3
Rhode Island	1880–89	0.1	5.3	26.6	29.9	45.1	7.9	27.6	75.7	133.7	86.2	29.0	5.7
Connecticut	1880–89	0.5	5.4	15.8	32.4	47.2	6.9	22.9	75.3	124.5	80.3	25.3	5.8
Massachusetts	1880–90	0.4	5.7	12.2	34.2	48.3	6.5	23.7	82.1	151.3	74.7	28.4	4.9
New Jersey	1880–89	3.0	5.8	25.5	. . .	53.4	7.9	25.8	. . .	131.3	116.5	21.3	. . .

"The almost universal distribution of certain diseases, even in places and under circumstances which make it impossible to believe that the virulence of the germs can have been derived from another case (there having been no previous case of illness of any kind in the neighborhood), suggests the theory that the germs of these diseases may be almost universally present in an innocent state, and only become virulent when they are brought into contact with certain conditions inside or outside of the body." [2]

"The Modification of Disease by Season and Weather over

[1] Allbutt's *System of Medicine*, vol. vi., p. 17.

[2] *Handbook of Climatology*, pp. 53, 54.

and above the General Influence of the Different Climates.—Regular variations in the curves of mortality and sickness are noted as the seasons change, and these normal variations may be influenced by exceptionally bad or good seasons. The changes of weather from day to day also modify the normal seasonal curves."

Classification of Climates.

Climates may be classified for certain purposes according to the physiological and therapeutical effects; but the most useful classification for general purposes is a physiological one, as set forth in the appended tables:

TABLE A.—POSITION.

Sea climates,	Ocean climates.
	Island climates.
	Coast climates.
Land climates,	Low climates (up to 2500 feet).
	Medium climates (elevation up to 4500 feet).
	High climates (elevation from 4500 feet upward).

TABLE B.—TEMPERATURE AND HUMIDITY.

Cold climates,	Moderate . .	Dry,	Moderate climates.
			Extreme climates.
	Extreme . .	Moist,	Moderate climates
			Extreme climates.
Hot climates,	Moderate . .	Dry,	Moderate climates.
			Extreme climates.
	Extreme . .	Moist,	Moderate climates.
			Extreme climates.

The classification of climates is at the best extremely unsatisfactory, the important elements being so interlaced as to make a complete disentanglement of them for the purpose of grouping climates under separate heads almost impossible.

Ocean Climates.—The climate of the ocean, of course, varies considerably in different latitudes and under the remote effects of the land upon ocean-currents, as in the case of the Gulf Stream, where the waters heated in the Gulf are poured into the ocean and carry its heat for many thousands of miles, or, on the other hand, where the waters from the polar regions bring the melting icebergs toward southern latitudes. Apart from these special influences, however, the most marked characteristic of our ocean climate is its equability, not only of daily temperature, but also lessened contrast between day and night, summer and winter. The reason for this is mainly on account of the water absorbing the sun's heat by day, and then returning it to the atmosphere by night. On shore the earth's surface absorbs but little of the sun's heat, and instead radiates it back

into the air at once, thus greatly increasing the aërial temperature, while at night, there being little heat to be returned from the earth, the natural cooling of the air goes on without being mitigated, as it is over the ocean, by the heat from the water being returned to the air.

Another marked and constant characteristic is the great humidity of the air, due to the vapor given off from the water. This, of course, acting as a veil, lessens the force of both the sun's light and heat by day, by absorbing much of it as it passes through. At night this stored-up heat is given off, thus lessening the sharp contrast between day and night; and a similar change prevails between winter and summer. The sea-air is impregnated with saline particles, and in small amounts by the gases of iodine and bromine, and is free from dust and germs. The amount of ozone is always very large. The electricity is more negative than on shore, a return to equilibrium being more easily established. There is of course great mobility of atmosphere, and, owing to the absence of any wind-breaks, heavy winds often carry the climate of distant coasts over the ocean, and thus its natural equability is greatly modified.

Physiological Effects.—Owing to the radiation of heat from the surface of the body, due to the humidity of the air, there is a need for warmer clothing for those who undertake sea voyages. The inclination to sleep, the appetite, and metabolism of the bodily weight are usually increased, while the nervous system is soothed. In suitable cases the climate of the ocean acts as a sedative tonic.

Island Climates.—By these are understood only the climates obtainable on islands of moderate size: these if at a fair distance from the mainland often enjoy most of the qualities of a pure ocean climate, without the drawbacks of ship-life, and of course are influenced by latitude, ocean-currents, soil, and configuration.

Coast climates partake more or less of the characteristics of both sea and land. They have less equability, owing to the different radiation from land and water, as spoken of before. The humidity may also be greatly lessened by the proximity of deserts, as in Northern Africa and Southern California. Again, the precipitation is often changed considerably. Thus coast climates, though resembling in general qualities the ocean climates, have wide ranges of difference, so that life at the shore, on the sea, and on an ocean island have great contrasts and yet a strong family resemblance.

Inland Climates.—Inland climates of low elevation, under 2500 feet, have physical peculiarities, and, occupying as they do a position between sea and mountain climates, have for the most part, like those of the sea, high barometric pressure, lessening with elevation, and more or less humidity, diminishing, as a rule, with the distance from the ocean. The intervention of mountain-ranges, however, such as the

Coast Range of California, will cause the precipitation of the moisture of the sea-air, and thus give a comparatively dry air on the land side of the range at only a short distance from the sea. The dryest low inland climates are nevertheless generally found in the interior of the continents, most remote from the ocean. The humidity, again, is modified not only by proximity to the sea, but also to great lakes, rivers, and swamps, and further by the vegetation and quality of the soil. The mean temperature varies, in the main, with distance from the equator, while the variations between day and night, sunshine and shadow, summer and winter, being dependent on the amount of humidity, increase, as a general rule, with distance from the ocean. There are, of course, marked modifications of this, as where desert lands approach the sea or, as referred to, mountains intervene. The air is necessarily less pure and the amount of ozone less than on the sea.

The main division of low inland climates is into moist and dry, and these again into moist and warm, moist and cool, dry and warm, dry and cool.

The moist and warm combination, when extreme, is altogether unsuitable for therapeutic purposes, giving the hot damp climates where malarial and other fevers, such as yellow fever, abound. Coming between these and the next class are *the moderately moist and warm climates*, which, though generally occurring as coast climates, may be inland also, such as Florida and the coast region of Southern California, the climate of Florida being, on the whole, rather the more moist and warm. These climates act chiefly through their sedative influence upon the nervous system and the mucous membranes, and during their appropriate seasons the moderate rainfall and equable warmth allow of much outdoor life; and they are especially useful in affording an agreeable change in winter for those inhabitants of colder regions who desire for comfort or safety to avoid the rigor of their home climate. Moderately moist and warm climates are also often used by invalids with great benefit. Such climates are found at Rome and in Persia and the Riviera in Europe, and on this continent at Asheville in Western North Carolina (elevation 2250 feet), and at Aiken in Western South Carolina and Marietta and Thomasville in Georgia. The general indications for the therapeutic use of such climates is where the extreme effects of climate, such as are produced in sea- and mountain-air, are undesirable or dangerous.

Moderately moist and cool climates may be termed indifferent, having no marked characteristics, but are often of service on account of their accessibility and pleasant surroundings and encouragement to diversion of mind and body. Many of the mineral springs that are largely used are situated in such climates, as Baden-Baden, Wiesbaden, and Saratoga, and resorts in the foot-hills and sub-alpine places are mostly in

this category. In America, Evans[1] places in this group, with a general elevation of 2000 feet, the western slope of the Appalachian chain, the Adirondacks, and the Alleghany and Cumberland mountains. These, owing to their elevation and purity of air by reason of being mostly in uncultivated and sparsely-inhabited regions, have more positively beneficial qualities than the lower places first referred to. Pine forests and the opportunities for sport and camping also add much to their value.

Moist and cold climates are quite unsuited for therapeutic use, being the producers of rheumatic and catarrhal affections, as well as the breeding-ground of much of the phthisis that everywhere abounds.

Dry and warm climates are greatly used by invalids, and often with benefit. Such climates are practically not to be found in Europe. The west coast of Africa, Egypt, and Nubia, the Steppes of Tartary, and on this continent South-western Texas, the inland regions of Southern California, and the less elevated regions of Arizona and Utah, come within this class. Egypt may be taken as a type of the dry warm climates, and of this Dr. Weber writes that he has notes of 24 cases of phthisis, which spent from one to four winters in Egypt; of these, 6 were in the first stage, with 4 cases improved and 2 grown worse; 12 in the second stage, with 6 improved, 3 grown worse, and 3 with no positive change; 6 in the third stage, with 2 improved, 3 grown worse, and 1 no decided change—a total improvement of 50 per cent. of the whole 24. In the first stage 66.6 per cent., second stage 50 per cent., third 33.3 per cent., were improved.

In 10 cases of emphysema with chronic catarrh, 9 improved. In 16 cases of chronic rheumatism, 14 improved. Out of 9 cases of chronic gout, 8 improved. In several patients with long-continued diabetes, who were at or past middle age, improvement was noted. Of 11 cases of albuminuria, 4 improved, 4 remained stationary, 2 grew worse, and 1 died. Some cases of heart disease with bronchial catarrh and digestive disturbances did well; so also did some with neuralgic affections, premature ageing, and nervous exhaustion from mental work or business care.

I visited Egypt several years ago, remaining six months, from October to April, during which time I frequented the hospitals in Alexandria and Cairo. At the latter point I remained some time, making excursions from it, and then spent four months on the Nile, going into Nubia as far as the Second Cataract, during which time I was frequently consulted by visitors and by invalids, both native and foreign. The conclusions I formed of the effect of the climate upon disease confirm what I have quoted from Dr. Weber.

On this continent the regions with an elevation of less than 2500

[1] *Phthisiology*, by G. T. Evans, M. D., D. Appleton & Co., N. Y.

feet, which are similar to Egypt in climate, have been but little used, and have at present few means of ensuring comfort and resource for invalids. Portions of Western Kansas and Southern Arizona are somewhat similar in climate, more particularly the latter, and tend to benefit much the same class of diseases.

Weber says *dry and cold climates* are not yet used therapeutically; he has seen 4 cases of phthisis in the first and beginning of the second stage, when business took them to Labrador, 3 of whom entirely recovered in the course of from four to six years. The fourth was unimproved. All four patients were powerfully-built men, free from other disease and without hereditary taint. Thus, the four cases, Weber says, might be called "selected," and he would not advise the climate for weakly persons. I had under my care in Colorado a patient of fine physique who had tuberculous ulceration of the larynx and consolidation at one apex. While in this condition, and having the pulmonary symptoms with aphonia and dysphagia, he went on the Greely relief expedition to the North Pole, and while under the influence of the dry cold air all his symptoms improved. Returning to the Eastern States, he got worse, came to Colorado, improved again, his larynx healing, and with all the signs of arrested disease he went back East, and there succumbed to a general tuberculosis, dying ultimately from meningitis. In a less degree, during the winter season the climates of parts of Canada, Minnesota, Nebraska, and Dakota rank in this class. Benefit to cases of pulmonary tuberculosis in an early stage and in robust persons are reported from all of them, but the cases that will do well in such climates do far better for the most part, and more certainly, in dry, elevated regions.

Elevated Climates.—The first in importance of the physical peculiarities of elevated climates is rarefaction, or lessened barometric pressure, while the next peculiarity of importance is coolness of air, with, at the same time, greater direct heat from the sun, especially in winter. The temperature of the air is very slightly raised by sunshine passing through it, for the reason that there is so small an amount of moisture in it. For this reason the sunshine is very hot and the air very cool in elevated climates, and these contrasts are especially marked during the winter, owing to the greater dryness at that season.

The dryness of the air—that is, both the absolute and relative humidity—is low in elevated climates, though the rain- and snowfall is sometimes considerable, and the movement of the air, except in sheltered valleys, is constant and not excessive, though wind-storms are common.

In elevated climates the air is aseptic, for there is very great freedom from inorganic and organic impurities and miasmata. The causes of this are not determined, but they may be due to the follow-

ing conditions: first, to the low humidity, bacteria and kindred micro-organisms thriving better in damper air; second, to the cold nights, destroying many forms of life; third, to the perfect oxygenation, the oxygen not being replaced by other and noxious gases; and, fourth, possibly by the greater energy of the electrical state of the earth and air. However, where unhealthy conditions exist, as in crowded cities with numerous invalids, even at a considerable altitude, the aseptic quality of the air disappears.

The increased light of elevated climates has been shown, by the experiments of Downes, Blunt, and Moleschott, to destroy bacteria and increase oxidation; and there is a relative increase of ozone, which is presumed to be allotropic oxygen, or, in other words, oxygen in an especially active state.

Positive electricity is also present in a higher degree, and dryness of soil usually exists.

The General Physiological Effects.—"The most important of these effects is that caused by the rarefied air, which, on account of the deficiency in oxygen, causes an increase of red corpuscles and hæmoglobin in the blood. This deficiency in oxygen, or rather in oxygen-pressure, at first compels quicker respiration, but later causes a deeper breathing, which permanently enlarges the chest. As a consequence of this rapid breathing the heart's action is increased; and when, later, the respiration becomes normal in rate, though increased in depth, the heart's action returns to its accustomed rate, but each beat is more forcible and the cardiac muscle is permanently strengthened.

"At altitudes varying from 5000 to 8000 feet the inconvenience of the unacclimated seems to have its origin in the increased respiratory activity, and this, in turn, leads to increased work of the heart, which, by its overwork, causes at first an active hyperæmia and an irritability of the nerve-centres. Later the nerve-centres suffer from imperfect nutrition induced by a poor blood-supply, which results from passive hyperæmia. We have, then, the 'irritable weakness' of the old pathologists. After the nerve-centres have become irritable neither the respiratory act nor the heart's action is performed as regularly and methodically as in the normal condition, and in consequence various unpleasant symptoms are experienced by the unacclimated. Persons possessed of considerable vigor and capable of adapting themselves to greater changes in their environments go to high altitudes and live almost as they had done at sea-level, and find no appreciable inconvenience in doing so; but for those advanced in years and for those of feeble health the consequences are far different."[1]

[1] "Nervo-vascular Disturbances in Unacclimated Persons in Colorado," by J. T. Eskridge. *Transactions of the American Climatological Association*, 1891.

"The foregoing, in conjunction with what appears under the head of decreased barometeric pressure, gives the chief points concerning elevated climates. Nothing has been said concerning climates in which the elevation was between 2500 and 4500 feet. Though there are many good resorts within these limits which exhibit more or less the characteristics of elevated climates, still such characteristics do not begin to be markedly manifested at less than 4500 feet above sea-level."[1]

The activity of the skin is increased, and it is better nourished and strengthened in an elevated climate.

As a rule, there is either a transient or permanent increase in the appetite and in the assimilation of nourishment, and therefore an improvement in the formation of blood and in general nutrition.

The nervous and muscular systems become stronger in elevated climates, and sleep is generally improved.

Summer and Winter Climates.—We have thus far referred to climates as to their general characteristics, but it is important for therapeutic purposes that they be divided into summer and winter climates.

Summer.—In estimating the effects of the various summer climates it is necessary to take into account the refrigerating effects upon the animal economy by the evaporation from the surface of the body when exposed to heated air. We are indebted to Prof. Mark W. Harrington for first calling attention to this important subject in his paper on "Sensible Temperatures:[2]"

"The published temperatures of the different weather-stations are the readings of the ordinary dry-bulb thermometer. The influence of evaporation is shown by what is called the wet-bulb thermometer, the bulb having a covering of cotton or muslin which is kept moistened. The consequent evaporation from the surface of this wetted bulb is similar to that of the human body from which the perspiration is evaporated, thus causing coolness. The temperature shown by the wet-bulb thermometer is called the "sensible" temperature, and is supposed to be the temperature felt at the surface of the skin. As a matter of fact, it is probably lower, because the cloth covering the wet-bulb is continuously saturated with water, while the surface of the skin is usually but slightly moistened and is not subjected to such rapid evaporation. The wind is an important factor in sensible temperature, because if the air is in motion that portion which is in contact with the human body is continuously replaced by dry air, while if the air is stationary it becomes slightly warmed and more humid from heat and moisture of the body, and the amount of evaporation

[1] *Handbook*, pp. 61, 62.

[2] *Transactions of the American Climatological Association*, 1894.

from the surface of the skin is necessarily less. The amount of the reduction or cooling of temperature is in direct ratio to the dryness of the air. It will be greatest where the air is driest, least where the air is most moist. The greater the depression of the dew-point below the ordinary or shade-temperature the less the relative humidity; the drier the air the more rapid the evaporation and the greater the consequent reduction of temperature.

"In Washington, Philadelphia, or San Francisco, where the moisture is usually abundant, the dew-point is usually not far below the shade-temperature, evaporation is relatively small, and hot weather *feels* hot. On the other hand, at Denver, Santa Fé, or Prescott, where the moisture is usually scanty, the dew-point is much lower than the shade-temperature, especially in hot weather, and the reduction is great—the greater the higher the temperature.[1]

"This is true of all arid regions, where the difference between the dry- and wet-bulbs during the warmest and driest portion of the day will range from 20° to 40° F., or more."

Captain W. A. Glassford, in writing on this subject, published the following valuable table:

Signal Service Stations.	July Temperature.			January Temperature.		
	Metallic Record.	Sensible Temp.	Difference.	Metallic Record.	Sensible Temp.	Difference.
Atlantic City, N. J.	72.3° F.	68.6° F.	3.7° F.	31.1° F.	29.3° F.	1.8° F.
Baltimore, Md.	76.5	68.6	7.9	32.4	30.9	1.5
Boston, Mass.	70.6	64.1	6.5	25.6	23.5	2.1
Chicago, Ill.	70.6	64.3	6.3	20.7	19.1	1.6
Denver, Col.	72.1	57.0	14.2	27.9	22.9	5.0
Eastport, Maine	60.6	56.7	3.9	21.2	19.5	1.7
El Paso, Texas	82.6	64.8	17.8	42.3	35.5	6.8
Los Angeles, Cal.	70.0	63.0	7.0	53.0	47.0	6.0
Nantucket, Mass.	70.2	67.3	2.9	28.9	27.4	1.5
New York City, N. Y.	72.9	66.6	6.3	28.4	26.7	1.7
Philadelphia, Pa.	75.4	68.8	6.6	30.0	27.8	2.2
Prescott, Arizona	72.5	59.5	13.0	34.0	29.5	4.5
St. Louis, Mo.	77.6	71.2	6.4	26.4	24.4	2.0
St. Paul, Minn.	70.2	64.0	6.2	7.4	6.4	1.0
Salt Lake City, Utah	75.6	60.0	14.7	27.1	23.3	3.8
San Diego, Cal.	67.5	62.9	4.6	53.7	48.9	4.8
San Francisco, Cal.	59.4	55.8	3.6	49.4	46.4	3.0
Santa Fé, N. M.	68.8	55.9	12.9	26.3	22.6	3.7
Washington, D. C.	76.0	69.0	7.0	31.0	29.0	2.0
Yuma, Arizona	91.1	75.0	16,1	52.8	45.3	7.5

"During the summer the extremes of heat sometimes felt in Eastern cities are almost unbearable. In New York, for instance, there may be several days when the ordinary shade-temperature reaches over 90° F., and the relative humidity may be 80 to 85 per cent., or over, which means that the difference between the wet- and dry-bulbs is only from 4° to 9°; that is to say, the sensible temperature is 81° to 86°, which is oppressive, as there is so little evaporation. With

[1] Harrington, *Transactions of the American Climatological Association*, 1894.

an ordinary shade-temperature of 90° F. in arid regions, and a difference of 30° F. between the dry- and wet-bulbs, the relative humidity will be 32 per cent. The air will not *feel* hot because the sensible temperature, which is the temperature the body endures, will be but 60° F., and the dryness in the air insures rapid evaporation.

"The advantage of this increased evaporation in the arid country of the United States is not merely theoretical. It is very real, and makes impressive the fact that 80° [1] at Charleston and 88° F. at Santa Fé are two different things." [2]

Winter.—Similar temperatures have a different value in winter to what they have in summer. On this subject General W. H. Greely writes as follows: "Next in importance to the temperature is the humidity of the air, a subject to which the public does not pay due attention, partly through inadvertence and partly through lack of accessible data. . . . While at all times sensations of dryness or moisture (and in summer rapid evaporation, which lowers temperature and promotes comfort) depend largely on the relative humidity, yet, during the winter season, the absolute humidity becomes a most important and potent factor in determining the fitness of any particular climate or sanatorium." [3]

The chart which accompanied this article showed that the least amount of absolute humidity exists in the extreme cold of Canada. "On the Atlantic coast the absolute humidity south of Charleston increases steadily from 3 grains to the cubic foot of air to 4 grains a little south of Jacksonville; 5 grains across the Florida peninsula from Tampa to Indian River; 6 grains at Miama, and 6.6 grains at Key West. Pensacola and New Orleans have about $3\frac{1}{2}$ grains; Galveston, $5\frac{1}{2}$ grains; San Diego, $3\frac{1}{4}$ grains.

"A *cold, dry atmosphere* will be found near the Rocky Mountains above latitude 35°. A *warm, dry atmosphere* is found in western Texas, southern New Mexico and Arizona, and southeastern California.

"The greatest softness and mildness in the United States are found along the California coast, where General Greely says the *daily variation* of temperature during the winter months scarcely exceeds 2° F. Arizona and the interior valleys of California average 3° F., as do the Gulf coast and Florida south of St. Augustine. The rest of the country varies from 4° to 6° F., increasing toward the Canadian border; from the Gulf coast northward the variability increases one to two degrees during the months of January to March.

"The resources of the United States in the matter of climate are very varied, from the mountains, lakes, and rivers, and elevated

[1] *Handbook of Climatology*, p. 65. [2] *Ibid.*, pp. 62, 63.

[3] *Scribner's Magazine*, November, 1888, "Where shall we Spend our Winters?"

plains along the Canadian border to the extreme southern limits of Florida and Texas.

"In spite of the increasingly good work of the Weather Bureau, detailed meteorological reports have been generally meagre, and it must be many years before all of the attractive though comparatively unknown districts of the country can be brought into general notice.

"The best climatic advantages of the Alps can be found in an improved form—because available all the year round—in the ranges, valleys, and plains of the Rocky Mountains; similar climatic conditions to those of Egypt prevail in the deserts between El Paso (Texas) and Palm Springs of Mohave (California); while the equable climate of the Riviera, with the same advantage of the protection afforded by the mountains above the coast, with a smaller amount of annual rainfall and less discomfort from harsh, cold winds, is to be found in Southern California. Florida, too, offers an asylum for winter visitors, especially on the Atlantic coast at St. Augustine, and southward to Lake Worth; while Key West is an excellent example of a warm, equable, and very moist climate. Unfortunately, there are no complete meteorological records relating to St. Augustine. There is, however, a weather-station at Jupiter, just south of latitude 27°, where there is a lighthouse. Jupiter is eight miles north of the upper end of Lake Worth, on which is the new winter-resort of Palm Beach.

"Among interior health resorts in the Southern States, Aiken, Thomasville, and Asheville have many advantages, which are referred to in the descriptions of those places.

"In that portion of the country known as the Great Southwest the winter climate of Colorado, northern New Mexico, and Arizona may be characterized in a phrase as *cold, dry;* that of New Mexico, and Arizona south of latitude 35° as *warm, dry;* and that of the coast of Southern California (west and south of the mountain-ranges) as *warm, moist.*

"In Colorado during the winter months (December, January, February) the day-temperature on the plains between 12 M. and 2 P. M. averages 40° or 45° F., and the relative humidity at the same time will probably range between 30 and 35 per cent.

"As the reported daily means include the lowest temperature during the twenty-four hours, the extreme cold of 2 to 4 A. M. greatly reduces what is termed the mean monthly temperature, which, for Denver, Colorado Springs, Pueblo, and Santa Fé (classifying the latter with the Colorado climate) is about 30° F., with a mean relative humidity of 54 per cent. and a winter rainfall of from one to two inches. Cañon City has about the same mean winter-temperature, 34° F., but it is more sheltered from the wind.

"A resort can hardly be said to have warm winters if the monthly

mean temperature for that season is less than 45° F. It need not be considered a disadvantage—especially on the seacoast—if it is over 60° F.

"We see, then, that to get the benefit of greater warmth it is necessary to go south of latitude 35°.

"Arizona affords the best desert climate of the United States, and, as winter-residences for health-seekers, it possesses the three towns of Tucson, Phœnix, and Yuma. As the entire territory of Arizona is west of the great Continental Divide, and slopes steadily toward the Pacific, it is subject to a certain amount of ocean-influence—not to the extent to which the winter-rains in California bear witness, but sufficiently to be subject, between December and March, to occasional rains and snows on the high plateaus and on the southwest slope of the mountains. There are few cloudy days in Arizona and the spring weather is usually dry.

"The greater part of New Mexico—about four-fifths—is situated east of the Continental Divide, and enjoys almost rainless winters. It has also a dry spring. Colorado also has little rainfall during the winter, but it is one of the disadvantages of the climate that this cannot be said of the spring. The normal rainfall at Denver and Colorado Springs for the months of April and May is 4.8 and 4.6 inches respectively; while for El Paso and Phœnix it is less than one-half an inch for the same period.

"The entire country south from Denver and then west in a wide curve to Los Angeles has a greater amount of sunshine; and on the elevated inland plains east of the 115th degree of longitude the air is cool, balmy, and very dry.

"In southern Texas a *warm, moist* climate is found at San Antonio, the location of which is about as far south as that of the city of Chihuahua in Mexico. Chihuahua has, however, a much greater altitude and a climate more resembling that of El Paso."[1]

Diseases in which Climatic Change is Indicated.

The disease must be of a chronic character, though occasionally a change during an acute stage of the illness is called for, as when the heart or nervous system is being unfavorably influenced by the climate in which the invalid is placed. Acute tuberculosis also is often arrested by a suitable change. The most important of the diseases for which change of climate is properly prescribed is tuberculosis, especially that of the lungs. We will therefore proceed to inquire into the influence of climate upon phthisis with regard to its production.

[1] *Handbook of Climatology*, pp. 67–69.

Phthisis.

What are the essentials of a climate for the cure of phthisis? The first and most important, and the one upon which all writers are agreed, is *purity of air*—not necessarily antiseptic air. The air being the chief food of the lungs, which are the parts in which the lesion exists, must necessarily be pure in order to effect an improvement. For this reason we find from the researches of Hirsch, Weber, Evans, Copland, Woeikof,[1] and others that there is least consumption among the people who dwell on mountains or on open and comparatively uninhabited plains, such as the Great American Desert, the African Desert, and the Steppes of Tartary, and on certain islands and sea-coasts. Although there is no zone of freedom from phthisis upon the surface of the land or sea, it being found everywhere, yet, as has been stated, it is relatively rare in the following order—viz.: On certain sea-coasts, on certain islands enjoying as nearly a pure ocean climate as possible, in desert places of wide extent, as found in the interior of continents, in polar regions, and, finally, most rare at elevations and increasing in rarity with altitude. Further, the experiments of Brown-Séquard, Stokes, Trudeau, and others show that when animals which have been successfully inoculated with bacillary matter are kept in confined spaces with imperfect ventilation, they become tuberculous, while those which after similar inoculations are kept in open-air quarters escape the disease.

In regard to *temperature*, Hirsch[2] shows the fallacy of the theory, on the one hand, that consumption is most common in cold or temperate climates, and on the other that it is not common in warm and hot climates; and he further states that "the mean level of the temperature has no significance, as will be seen from the facts already given, and particularly from the statistics of mortality for the frequency or rarity of phthisis in any locality." But it exercises a very decided influence on the course of the disease; for, according to nearly all authorities, in tropical countries, including India, Cochin China, China, the Pacific islands, the Andes, the west coast of Africa, the West Indies, Panama, Guiana, Brazil, and Peru, consumption usually runs a much more rapid and pernicious course than in higher latitudes, the removal of the patient from such a climate as speedily as may be being in fact the only sure protection against a rapidly fatal issue.

During a practice of twenty-five years' duration in Colorado, largely among the consumptive visitors, I have observed that in those in whom the disease had developed in warm climates the malady was usually much further advanced in the same length of illness than in those coming from cool climates, and that the tendency in most of the former

[1] *Die Klimata der Erde.*

[2] *Handbook of Geographical and Historical Pathology*, vol. ii.

cases was to run a more rapid course and more frequently to end fatally than in the latter.

Severe and sudden changes of temperature from day to day have no more determining influence, *per se*, than has the absolute height of the temperature. Hirsch refers to the evidence furnished in abundance from numerous places in the more elevated regions of North and South America which are little touched by the disease, although they are subject to very severe fluctuations of temperature. The evidence shows that *variability with dryness of air* has at least no prejudicial influence on phthisis, except, of course, in some special cases; and there are many theoretical reasons, and I believe good practical ones also, as will be shown later, for believing these qualities to be beneficial.

Hirsch has shown that *variability with dampness of air*, when conjoined with frequent oscillations of temperature, predisposes to phthisis, while, on the other hand, *damp heat* has been shown not to have a positive influence in its production, but a very decidedly unfavorable one upon its progress when once established.

Damp cold, however, is proved to be very positively active in the production of consumption, and most injurious to those in whom it has developed; and *dampness of soil* has been incontestably proved by the investigations of the elder Bowditch, Buchanan, Milroy, Pepper, and many others to be a most potent factor in the production and progress of phthisis—very much more so than dampness of air, either hot or cold.

Humidity of the air does not in itself, apart from other factors, apparently produce phthisis: the comparative immunity from consumption among the men of the British navy contrasted with those of the army, and the rarity of the disease upon many islands, such as the Faroe, the Shetlands, the Hebrides, and Iceland, show this. The influence of these climates and of sea-voyages on the disease when developed and active has, however, not been shown by the evidence of others or by my own observation to be beneficial, removal from the sea being generally of most advantage. Where benefit has been received in a sea climate, it would appear probable that it was owing mainly to the great purity of the air or the elimination of unsanitary conditions and hurtful occupations, as when an overworked citizen takes a sea-voyage or a Bostonian is sent to such a climate as the Isle of Shoals, or a Philadelphian to Atlantic City. Therefore, it is fair to assume that the beneficial influence of humidity upon phthisis, apart from other climatic factors, when it occurs, is purely negative. This does not, however, prevent the possibility of its being of positive benefit in occasional cases of phthisis in which the accompanying conditions of the circulation, nervous system, or mucous membranes demand a damp climate.

Dryness of air, on the contrary, has been known to be of positive benefit to the consumptive. The excellent results obtained from desert air (apart from altitude, which we will consider later) are too well known to quote at length. The benefit derived from the Steppes of Tartary is often mentioned, and I myself have, while on the spot, noted remarkable results produced by the climate of Upper Egypt and in Arizona and the Mojave Desert, lying behind the littoral of Southern California. Some years ago, while practising in London, I noted great improvement in the general and local signs of phthisis in several cases of consumption which were tending to deteriorate, after they had been employed for several months as shampooers in the Turkish baths, where they lived for most of the twenty-four hours in a very dry and superheated air. That the dryness, and not the heat, was the cause of the improvement may be fairly inferred from the fact that hot moist climates are not beneficial; and I may add that, from inquiries I have made in Egypt and elsewhere, where the so-called Russian or hot vapor-baths are in vogue, consumptives are very properly warned against their use.

With respect to the rarity of phthisis in dry low climates Hirsch writes as follows: "There are few countries of the world so characterized by uniformity of temperature and comparative dryness of the air as the inland districts of Lower Egypt and the valley of the Nile in Central and Upper Egypt—regions in which phthisis, according to all observers, is very uncommon. On the other hand, as we have already seen, localities on the coast, such as Alexandria, Damietta, and Port Saïd, with a moist climate and a great range of temperature, are much more subject to the disease.

In crediting dryness of air, *per se*, with a beneficial influence upon phthisis, we must not forget that some share of the credit at least belongs to the other necessary accompanying factors of a dry atmosphere—namely, more powerful sunlight and heat, less depressing cloudy weather, cooler nights and shade, and a higher electric tension of the body. What is also of prime importance is the greater opportunity for exercising and resting in the open air and while the invalid is in the house, the windows being open by day and by night.

In regard to *altitude*, observers have differed as to the least degree of elevation at which its special characteristics are manifested, some placing it as low as 1500 feet, but most writers at 2500 feet, which is probably the more correct. What Hirsch writes concerning the relative immunity of great altitudes, and his theory of the cause, are pertinent and valuable. "The observations published by Archibald Smith and Tschudi as to the extreme rarity of phthisis on the high plateaus of the Andes in Peru, and as to the good effects upon the phthisical of a residence thereon, were the first statements to direct

general attention to the comparative immunity from consumption of regions at a great elevation. Further inquiries in the same direction have confirmed the general fact, but they have in part also given color to an opposite conclusion, so that the question may be said to be still *sub judice* for those who would decide it absolutely and without regard to accessory circumstances.

"It is not to be denied that phthisis does occur at the highest inhabited spots on the globe, and that it is rare in many places situated on low plains; none the less, it is an incontestable fact that consumption is, *cæteris paribus*, much less frequently met with at high-lying places than in those at a lower elevation or on the sea-level. Not only so, but the number of cases stands in some kind of definite proportion to the degree of elevation, while the exceptions to the general rule find satisfactory explanation in other etiological factors coming into play at the same time."

"There is no doubt," says Andrew, "that as regards altitude the prevalence of phthisis at considerable heights, although instances of it do exist, is exceptional; and Burkhart mentions that he had not seen a single case of phthisis during a period of three months among the Europeans occupied at the mines in Mexico."

Statistical inquiries, such as have been carried on in Saxony, Baden, and Switzerland, on the amount of phthisis in the elevated places as compared with low-lying places close at hand (due regard being had to any differences in the mode of life), have confirmed the law of immunity of the more elevated places from phthisis which had been deduced from the study of the higher elevations by themselves.

Corval has worked out this relationship from the Baden bills of mortality over a period of four years (1869–72), including in his total, as he was bound to do, all those cases in which the cause of death was given as tuberculosis, "chronic pneumonia," or "phthisis." He distinguishes six groups of localities according to elevation:

Table of Mortality from Phthisis in Baden, according to Elevation.

Elevation in feet.	No. of towns or villages.	Population, average of four years.	Death from phthisis per 1000.
I. 330–1000	750	933,773	3.36
II. 1000–1500	337	224,210	2.75
III. 1500–2000	160	81,066	2.60
IV. 2000–2500	190	104,289	2.75
V. 2500–3000	97	59,155	2.33
VI. Above 3000	47	20,367	2.17

"In order to ascertain what effect is produced upon the death-rate from phthisis by density of population, industrial pursuits, and other

things peculiar to towns, we may make a calculation of the mortality according to the size of every town or village in Baden, using Corval's figures: we shall find, accordingly, that it is 3.12 per 1000 inhabitants for the whole of Baden, 3.00 for villages of 3000 and under, and 3.49 for towns from 3000 to 10,000, and 4.56 for towns with more than 10,000 inhabitants. If, now, we arrange the places that are respectively over and under 3000 population in two columns, classifying them in six groups according to elevation, we shall get the following table of the death-rate from phthisis:

Altitude-Groups.	Under 3000 Population.	Over 3000 Population.
I.	3.11	4.05
II.	2.73	3.08
III.	2.49	4.99
IV.	2.71	4.72
V.	2.29	3.06
VI.	2.17	

In the series with less than 3000 inhabitants the favorable influence of increasing elevation is quite obvious, but in the second column of death-rates it will be seen that the benefit is in some circumstances more or less neutralized by detrimental factors belonging to the social and industrial life of the large centres or the towns. Still, from the facts, such as they are, we may adopt Corval's conclusion, that "cases of phthisis decrease with increasing elevation; or, in other words, in mere increase of altitude we may discover one of the most important factors in checking the development of consumption."

"What the minimum elevation is that a locality must have before it feels the good effects of altitude on the prevalence of consumption is a question that cannot be answered with certainty from the facts before us. Gastoldi puts it at 600 to 1000 metres (2000 to 3300 feet); it seems to me, however, that a notable decrease in the disease can be shown to occur at as small an elevation as 400 or 500 metres (1500 feet), provided other circumstances are favorable. But any immunity from phthisis due to the height of the place does not come out decidedly until we go to elevations so great as to be uninhabitable in temperate climates like that of Europe. We must go to the equatorial parts of the world to study the sanitary effects of altitudes ranging from 2000 to 3000 metres (6000 to 10,000 feet), and, inasmuch as the question is one of populous places and the seats of industry, we must take the large towns on the plateaus of the Andes in Central and South America, such as Puebla, with 80,000 inhabitants and at an elevation of 2300 metres or 7500 feet, Mexico (320,000 inhabitants, 7500 feet), Quito (60,000 inhabitants, 9300 feet), Bogota (40,000 inhabitants, 8500

feet), Chuquisaca (25,000 inhabitants, 9800 feet), Cochabamba (40,000 inhabitants, 11,000 feet) and Potosi (20,000 inhabitants, 13,000 feet). In all of these, which are to some extent industrial towns, or at any rate much occupied with trade and commerce, and by no means models of good sanitation, consumption, according to the unanimous testimony, is either rare, or, among the natives, it does not occur at all. And that is a proof that the influences which go with a very considerable altitude have the power to overcome those detrimental things that arise from a bad kind of hygiene and social life, in so far as these tend to produce consumption."

Opinions differ as to the nature of the influence of altitudes. Some trace it to the freedom of the air from decomposition-products, dust, and the like; others to the dryness of the air and soil; both of which opinions seem to me to be overthrown by the facts given above, as well as by the circumstance that the immunity from consumption occurs equally on dry and on damp plains, or in mountain-valleys abounding in lakes and pools, provided only that they stand at a considerable elevation. The only explanation that I can offer, and one to which I shall hold until something more satisfactory presents itself, is that people who have been born and brought up at great elevations have been always under the necessity of making frequent (or perhaps deep) inspirations as a consequence of breathing a rarefied atmosphere—that they are continually practising a kind of pulmonary gymnastics, from which there proceeds a vigorous development of the breathing organs and a greater power of resistance on their part to noxious influences from without. I do not hesitate, therefore, to believe that the reason of the immunity from phthisis enjoyed by the residents of elevated places is the influence which a continuous residence in a rarefied atmosphere exercises over them.

"On the other side, we may thus further explain the exemption from phthisis of many parts of the world by reason of their favorable weather-conditions and the consequent rarity of all pulmonary affections therein. The immunity from consumption enjoyed by natives of elevated regions seems to me to be referable to a peculiarly strong development of their breathing organs, and a corresponding power of resistance in them to noxious influences from without; it is proved that this is now not at all an affair of 'purity of the atmosphere,' as some have supposed, by the fact that the state of hygiene in the towns of Ecuador, Bolivia, and Peru, situated at great elevations, is by no means distinguished for its excellence, for cleanliness in the houses or streets, adequate ventilation of the rooms, and the like."

There is little to be added to Hirsch's exhaustive and masterly array of facts and reasons setting forth the inhibitory influence of altitude upon phthisis. In Colorado, to which my personal observations upon the

influence of the altitude have been mostly confined, the native population is too small and youthful to gather any statistics, but living as I have done for the past sixteen years among a people of whom perhaps 30 per cent. came to the country with tuberculosis, and not a few of whom live under unhygienic conditions in crowded lodgings, and where free expectoration is carelessly practised, I know of very few cases of phthisis which could be fairly assumed to have originated in Colorado. Let us now see what is known of the influence of altitude upon phthisis, when developed, as compared with the effect of other climates.

Comparative Results of the Treatment of Phthisis by Climate.

The writer has dealt with this subject in his article upon "Tuberculosis" in the fourth volume of this *System*, published in 1897, as well as in the *Handbook of Climatology*. It is, therefore, unnecessary to dwell at length upon the subject and detail the evidence which supports the main conclusions at which the writer has arrived.

In his *Handbook of Climatology* full reference is made to the sources of information upon this subject. In order to obtain impartial evidence of the relative influence of climate upon phthisis the writer thoroughly searched the literature of the subject, and found reports of about 9000 cases of phthisis treated by climate, of which 7995 allowed of tabulation. The reports of the remaining 1000 cases were too imperfect to be classified, but as is there shown they would not have appreciably affected the main results.

In order to draw conclusions from so large and heterogeneous a mass of evidence it was necessary to limit the inquiry to the question whether or not the reporter considered the cases were benefited by the change of climate, as the length of the time which the patients were under the observation of the reporters was too varied to allow of any definite conclusions as to the permanency of the results.

The various climates resorted to were naturally separated into three main groups—sea, low-land, and high-land climates.

The *sea group* were subdivided into ocean, island, and coast. Under the head of ocean are placed reports of the cases who took sea-voyages.

Low-land climates were subdivided into low-land (exclusive of coast climates), sanitariums, and desert.

The low-land group covers the cases that were treated in low-land climates, exclusive of those treated in sanitariums and desert climates.

The sanitariums from which reports were obtained were all in similar low inland climates but none of them in deserts, and while under the same climatic influence as the low-land climates are placed

in a class by themselves because of the greater percentage of improvement, owing undoubtedly to the care and discipline of the institutions in which they were placed.

The cases treated in desert climates, such as Egypt and Syria, showed still greater improvement, owing doubtless to the greater dryness by reason of their greater distance from the sea, although the elevation above it was not markedly increased.

The third group, high-land climates, embraced all those cases which were treated in high altitudes above 4500 feet.

This inquiry showed that the most important climatic factors which influenced the progress of phthisis were, first, diminished barometric pressure; second, diminished atmospheric humidity; and in addition to these two purely climatic factors the results were influenced by the hygienic conditions with which the patients were surrounded—that is, the beneficial effects of sanatorium treatment are noticeable in influencing the percentage of those benefited in low-land climates.

In judging of the influence of altitude, which is chiefly that of diminished barometric pressure, we find that by dividing the reports into two classes, low climates and high climates, we get the following table:

Comparative Altitude.

	All stages.	First stage.	Second and third stages.
Low climates	59 per cent.	75 per cent.	47 per cent.
High climates	76 "	89 "	63 "

In order to estimate the relative influence of humidity the cases are arranged in three groups which mark their relation to the greatest amount of sea air:

Comparative Humidity I.

	All stages.	First stage.	Second and third stages.
Sea climates	57 per cent.	71 per cent.	38 per cent.
Inland climates	63 "	92 "	57 "
Climates of high altitudes	76 "	89 "	63 "

The desert climates, which are for the most part situated as great a distance from the sea as the high-land climates and enjoy even a greater amount of sunshine and dryness, are contrasted with the high-land climates in order to compare the influence of diminished barometric pressure when uncomplicated with the question of humidity and sunshine; and here we find the desert climate showing 65 per cent. of benefit while the high climates show 76 per cent.

To bring out more strongly the influence of humidity uncomplicated by diminished barometric pressure the effect of low-land and desert climates are given in the following table:

Comparative Humidity II.	All stages.
Low-land climates	58 per cent.
Sanatoria	63 "
Desert	65 "

To sum up, diminished barometric pressure is by these inquiries shown to exert a far more powerful influence in the arrest of phthisis than sea-air, desert-air, or even the hygienic control by sanatorium treatment, and in a slighter degree the dryness of the desert is of more benefit than sanatorium treatment in a damper climate.

So much for the general broad influence of climate upon cases of phthisis taken as a whole. There are, of course, many cases that are exceptions to these general laws, and there is no question that for the majority of consumptives a sanatorium treatment is the best, but a sanitorium in a good climate will obtain better permanent results than in a bad one. The investigations of which I have given this general analysis show that in the first stage of phthisis any marked change, climatic or hygienic, is attended with almost equal temporary benefit; that is, reports coming from all sorts of climates and sanatoriums show between 90 and 100 per cent. of benefit. Unfortunately the writer's experience induces him to believe that in a great many instances arrest is not permanent. For example, Colorado has many seriously affected invalids who have been reported as cures in various low climates and particularly sanatorium. The fact is, that while early phthisis is, in a large percentage of the cases, a curable disease, the results published, particularly by sanatorium authorities, are too optimistic, and the patients believing themselves cured return too soon to their former climates and environments and become once again negligent of hygienic precautions. When the writer was pronounced a consumptive thirty-six years ago the prognosis was usually far too gloomy; to-day it is too rose colored, and the patient and his doctor often mistake an arrest for a cure.

The final conclusion is, that a consumptive treated in an open resort in an elevated climate has three times as good a chance of recovery as has one treated in an open resort in a low climate, though only twice as good a chance as one treated in a *sanitorium* in a low climate. Though in prescribing a particular resort for a given case of consumption the decision is dependent on many minor points that are elsewhere referred to, yet the broad truth remains that of all factors, climatic or otherwise, in the treatment as well as in the prevention of phthisis, altitude is by far the most powerful of them all.

I will here finish this branch of our subject with an extract from a paper I read before the American Climatological Association, September, 1889, entitled, "Invalids Suited for Colorado Springs": "The most marked benefit is shown in antagonizing and arresting tuberculosis in those whose ancestry or physique, or both, convey the impression of

their being affected with a tendency to a general tuberculosis. Hæmorrhagic cases are found to do well. Phthisis consequent upon croupous pneumonia or pleurisy is generally benefited. The presence of a cavity is not, in itself, a bar to receiving benefit. Fibroid phthisis is usually improved. Cases of so-called catarrhal pneumonia generally do well, but if there is a marked tendency to acute febrile catarrh of the tubes or a specially irritable and useless cough, a more medium climate is indicated. Rapid progress and pyrexia are not contraindications if there is evidence of a sufficiency of healthy lung remaining, and if the patient is able to take and assimilate enough food, and shows a fair power of reacting to stimulation by cold and a capacity toward recuperation from fatigue. Very moderate dilatation of the heart in the young is not a positive contraindication if care is exercised, nor is old valvular disease if tolerated and compensated for. Albuminuria caused by lardaceous disease would be a decided contraindication. Any renal complication of phthisis makes the experiment of change to Colorado of extremely doubtful advantage, though chronic Bright's disease, without pulmonary disease, is usually favorably influenced. Chronic catarrh and inflammation of the throat, nose, or bronchi are generally improved, and even tubercular laryngitis is, *per se*, not a contraindication.

"To sum up as regards the individual, the anæmic and phlegmatic are best influenced; as regards the disease, the chronic, the first as regards the stage of the disease. A larger margin of sound tissue in the peccant organ is demanded than in changing to a less extreme climate, and a certain evidence of vital resiliency is imperative. With respect to pulmonary disease, let it be especially remembered that in sending your patients to Colorado you are putting them, as it were, in a gymnasium, and they will need prudence and instruction to benefit by it; that the whole principle of the influence of altitude upon chronic disease is the exciting of a healthy life in the place of an unhealthy, and that in the process there comes the strain of the battle; that in prescribing an altitude, to ensure success, as in prescribing the most powerful remedies of the Pharmacopœia, the method of administration demands our most careful consideration."

Cases of Phthisis Unsuited for Altitude Treatment.—The next best climate for most of these is undoubtedly a low, dry one: when, however, there is much irritability of the nervous system, the heart, or mucous membranes, a warm, not hot, climate, with medium dampness, is desirable for its sedative effect and through allowing much outdoor life. There are also climates where a partial effect of altitude is obtained at elevations between 2000 and 3000 feet. Dr. G. A. Evans, in his excellent *Handbook of Phthisiology*,[1] gives the following classification of the climates resorted to by consumptives in the

[1] *Handbook of Phthisiology*, G. A. Evans, D. Appleton & Co., N. York.

United States, which may be found of service in making a choice for a particular case, provided the governing principles have been previously grasped:

1. *Climate Cool and Moderately Moist.*—General elevation 2000 feet, western slope of the Appalachian chain, Adirondack, Catskill, Alleghany, and Cumberland mountains. 2. *Climate Moderately Warm and Moderately Moist.*—Between North Carolina, Asheville, elevation 2250 feet; Western South Carolina, Aiken, Georgia, Marietta, and Thomasville. 3. *Climate Warm and Moist.*—Florida (equable), Southern California, coast region (equable). 4. *Climate Warm and Moderately Dry.*—Elevation about 2000 feet, South-western Texas, Southern California, inland. 5. *Climate Cool and Moderately Dry.*—Elevation about 1000 feet, Minnesota, Nebraska, Dakota. 8. *Climate Cool and Dry.*—Elevation from 4000 to 7000 feet, Montana, Wyoming, Colorado, Northern New Mexico, and Western Kansas. 7. *Climate Warm and Dry.*—Elevation 3000 to 5000 feet, Southern New Mexico and Southern Arizona.

Affections of the Respiratory Tract other than Phthisis.

Convalescence from croupous or catarrhal pneumonia, when the patient is still weak and unable to exercise, is usually best hastened by a warm equable climate, in which time can be passed in lying in the open air; when, however, the clearing up of the affected portion of the lung is delayed, and yet the patient has recovered a sufficient amount of vigor to allow him to walk about and keep his blood in healthy circulation, an elevated climate will generally ensure more complete and rapid recovery, and the cool air, being dry, will prove especially beneficial.

Delayed recovery from pleurisy is generally best treated at an altitude. Convalescence from acute bronchitis is usually completed most satisfactorily in a warm low climate, as also is chronic bronchitis; if the latter proves intractable, it has usually tuberculosis behind it, in which case an altitude should be tried, unless age, emphysema, or heart complications forbid it; then a warm, dry inland climate of moderate elevation is best.

Asthma, when the neurotic element is the prominent symptom, is nearly always relieved most effectually in high elevations, and sometimes cured. When the asthma is evidently dependent upon or overshadowed by cardiac or bronchial complications, medium climates are best, the question of reflex irritation, nasal or otherwise, being first attended to.

Dr. C. Denison in his address as president of the American Climatological Association, September, 1890, reports on 52 cases of asthma treated in Colorado: 72.5 per cent. were more or less improved. All of the cases that got worse, and all but one of the stationary, had

more or less marked emphysema. This agrees with my own observation, that when there is marked emphysema resort to an altitude is useless, and often dangerous.

Chronic Laryngitis.—When tubercular, I am firmly convinced that treatment in an elevated climate is more apt to mitigate, and occasionally to cure, this usually hopeless disease than when administered in a low climate. My statistics, published in the *Transactions* of the American Climatological Association for 1890, show this. In chronic laryngitis, non-tuberculous, the climate must be fitted to the case upon general principles, and such questions asked, Does the disease improve most under sedative or stimulating treatment? Is the patient better in damp or dry weather? etc. The same rule applies to catarrh and chronic inflammation of the pharyngeal and nasal tracts.

Diseases of the Heart and Great Vessels.

As this subject has been mentioned before in connection with sea climates, I will here refer only to the influences of elevated climates, and thus, by placing before the reader the effects of the two extremes of climatic change, give the guiding principles for selecting a climate for a particular case.

It is a matter of universal observation in Colorado that the heart-beats are at first increased, and that in those with whom the climate agrees, and in whom there is no pathological condition preventing it, the heart-beat will return in time to its usual rate, the time being longer or shorter according to the general vigor and age of the individual. That one of the secondary effects is to make each cardiac contraction stronger is, I believe, true. The direct impression gained from observations by ear and finger on the relative strength of the contractions agrees with this. Pathological observation, however, is the best evidence. A considerable number of anæmic consumptives, especially when young, have a tendency, more or less developed, toward simple dilatation. Many cases which gives no signs at sea-level exhibit them on first coming to Colorado. Such cases, if permitted to exercise only with great care, generally gradually lose all symptoms of dilatation, and some in time show signs of hypertrophic compensation, if improvement in general health occurs, and if, of course, the cardiac muscle has not been stretched too far or is not degenerated, so as to prevent it from regaining its elasticity. The observations of Oertel confirm this view. Moderate dilatation in persons under thirty years, who otherwise the climate benefits, is often improved if they will submit to very strict medical discipline, especially in the matter of exercise; but practically such cases can usually be treated successfully in other places with much less risk than they encounter at this elevation. Graduated gymnastic exercises and climbing steps and moderate hills

can, I believe, be better used to strengthen the cardiac muscle than putting them under the continuous strain that living at an altitude of 6000 feet involves. Where the dilatation is marked the exercise at this elevation is necessarily so limited that the patient is apt to chafe under the restriction and break it to his own detriment, or suffer in general health for want of sufficient exercise to promote appetite and nutrition.

It is hardly necessary to say that all cases in which there is fatty degeneration of the heart, or in which there is evidence of grave valvular lesion without ample compensation, should not be exposed to the dangerous strain that the first effects of the climate involve. Cases are seen in Colorado who have passed through this period, and who, living a careful life, do comparatively well. No doubt in such cases it is because the secondary and chronic climatic effect is to equalize the blood-pressure throughout the entire vascular system and make the circulation vigorous and complete. All the finest capillaries being well filled, the continued effect is to relieve strain in all parts and to get rid of chronic local congestions. The most powerful proof that the foregoing statements are true is the fact that has been established by Archibald Smith, from his experience in the Andes, of a marked mitigation of the symptoms in cases of aortic aneurism; and this the observations of myself and my colleagues fully confirm. Nevertheless, in view of the great danger of permanent increase, during the early portion of the stay, or by sudden or violent exercise during any later period, it cannot be wise for the physicians to recommend such cases to come to this elevation. Were the American patient, like the German, more dependent upon the judgment of his physician, this advice would doubtless admit of modification; but, alas for the procuring of the best results of treatment, our patients have yet to learn that in many diseases the autocratic regulation of their daily exercise is the most valuable aid that medical skill can offer them. The decided effects of the altitude in exciting and disturbing the action of the heart in sensitive persons, even without disease, is shown by many who, after living comfortably for several years at this elevation, 6000 feet, ascend to the summit of Pike's Peak, 8000 feet higher. These persons, while there, except for a feeling of lightheadedness, are all right as long as they do not attempt to walk, when even a few steps taken will bring on rapid and often irregular beating of the heart, generally slight headaches, and often nausea and diarrhœa, and, in some, slight præcordial pain, the headache and pain over the heart often persisting more or less for twenty-four hours after their descent. Cases of valvular lesions in which there are no secondary complications, and there are exhibited accommodation and tolerance both local and constitutional to the impaired working of the organ

while the patient is prudent, are decidedly benefited by the tonic effects of altitude.

With respect to nervous affections of the heart the question of climatic influence must be approached from the nervous and not the cardiac side of the subject. Cases of anæmia and chlorosis are invariably relieved by the Colorado climate.

In choosing the climate for a patient with cardiac disease, apart from the question of atmospheric pressure here referred to, the promotion of the general health, and especially of encouraging the activity of the skin and kidneys, has to be considered, with a view of relieving the strain upon the circulation.

Diseases of the Nervous System.

Where organic lesions are progressing a sedative climate, such as a warm, sheltered sea-shore, is certainly the best. In chronic organic disease of long standing, with fair general health, a dry cold climate or a high elevated one may be cautiously tried when other climatic change has been unsuccessful; but age, atheroma, or cardiac complication would be decided contraindications. In cases of functional disease the turning toward sea or mountain is influenced by the question of whether a sedative or stimulant is called for. The former is the more suitable where there is much nervous irritability with a good circulation, and the latter when it is accompanied with a feeble pulse and cold extremities. The same also holds good when there is nervous depression, mental or general. With respect to the influence of altitude upon nervous diseases, Dr. F. T. Eskridge of Denver read a valuable paper before the Climatological Association, September, 1890, and I reported on cases treated in Colorado to the Colorado State Medical Society, 1879; both of which support the foregoing conclusions.

Neurasthenia.—One of the most serious symptoms of this disorder is usually insomnia, and the climate which best relieves this is the one in which the greatest general benefit will be found. As showing the effect of altitude upon neurasthenia, I will quote five cases treated in Colorado which I reported some years ago. The conclusions drawn from them have been confirmed by more recent clinical experience.[1]

In judging of the effect of the climate it is necessary to separate the improvement that is specially due to the particular locality from that which is due to the influences common to any place where the patient enjoys fresh air, sunshine, and relaxation from strain and worry. This separation can only be effected satisfactorily when the patient has tried other climates for the same symptoms. In five cases

[1] "Influence of the Climate of Colorado upon the Nervous System," by S. E. Solly, *Colorado State Medical Society Transactions*, 1879.

of which I have notes the patients had tried other climates. The outlines of these I will briefly give:

Case 1. D. B——, aged thirty-four years, secretary to a railroad company, enjoyed good health up to 1870, when he began to be much worried and overworked; went to Europe in consequence of breaking down with the following symptoms: Insomnia; forehead-ache; irritability of temper, with depression of spirits; inability to fix his attention on writing or reading for more than a few minutes at a time; rheumatic pain in the calves of both legs, increased by walking; frequent perspiration, then "pins and needles" in legs; later, tingling in arms, then forearms and hands, preceded by what he called a "nervous grip," beginning in the neck and passing around to the jaws; at the same time some want of control over the bowels, not over bladder; cardiac palpitation; digestion easily upset; some tremor and no vertigo. He travelled in Europe for a year, then returned home with all the symptoms abated and in good general health, but not entirely recovered, as proved by inability to do much work for some time; then got into fair health, worked hard, and in March, 1876, same symptoms began to come back, and in October, 1876, he came to Colorado Springs, at that time much worse than in the first attack. Did not see much change on first coming, except that he slept better. Came under my care on October 27th. He was treated with tonics, a diet for trouble of bowels, moderate exercise, and bromide of potassium when required. He had some nervous attacks, brought on by unusual exercise or excitement, when he felt worse than he did when at home or in Europe; they quickly passed off, and in the main his improvement was steady, until, at the end of January, 1877, all his symptoms had disappeared, and he was able to apply himself for several hours to reading or writing without feeling any bad effects. By my advice he then left Colorado for a trip through the South with friends. He continued to gain strength, and resumed his official duties in the following May, and was married in the fall. I have heard from him recently as being perfectly well and equal to any ordinary work. In this case a residence of four months in Colorado did more for him than a year's trip in Europe.

Case 2. H. H——, lawyer; aged forty-eight years; had previously enjoyed good health, and had worked hard for twenty years at his profession. In 1870 he broke down, with violent headaches, especially at the back of head and neck, insomnia, slight vertigo, nervousness, inability to concentrate his mind, and there was present phosphatic urine. He now took a sea-voyage, and travelled in China and elsewhere for more than a year. He partly recovered, though he was not so strong as before; and he did not improve at all till the last few months of his holiday. The same symptoms returned in May, 1877, and continued

to increase until he was obliged to give up work and come to Colorado for a rest, which he did on July 16, 1877. He said he was not quite as bad as when he went away eight years before, but he felt he would soon be so if he continued working. Except for sleeping better, he did not feel any relief till he had been in Colorado about a week, when he began to pick up. He remained at Manitou a short time, when, excepting for regulating his bowels, no treatment was carried out; he then made a fishing and shooting excursion of two months' duration through the mountains, at the end of which his symptoms had vanished, and he said he felt equal to work again, and returned home to resume work in a modified form. In this case the symptoms were not so advanced as when he took his sea-voyage, yet the effect of the change of air was much more striking and rapid in Colorado.

Case 3. F. G——, aged forty-two; engaged in an extensive business; has worked hard all his life in his office; always dyspeptic; dyspepsia became worse in December, 1876, and to it were added certain nervous symptoms—headache, insomnia, and nervousness, differing from those arising previously from dyspepsia. He arrived at Manitou August 10, 1877, and continued the same treatment as before for the dyspepsia. He lived most of the time out of doors, and returned home in five weeks with nervous symptoms entirely removed and dyspepsia much improved. He wrote me last month from Pau, in the south of France, that, his trouble having returned during the winter, he had gone to Europe, and, though improved, did not find that he recovered as quickly as before, and believed Colorado was the best climate for him. In this case the dyspepsia was evidently dependent upon the nervous exhaustion.

Case 4. H——, aged forty-nine, merchant; had been tied down to his business for many years; had twice before been attacked with dull pain in back of head and neck, insomnia, languor, and nervousness. He had each time gone to Europe and returned well. He came to Colorado in April, 1878, with the same symptoms as before; and remained only three weeks, but his symptoms left him after he had been here a week.

Case 5. R. S——, aged forty-five, manufacturer; had always worked hard at his business; three years before had an attack of pain across forehead, with vertigo, and sore feeling in back of neck, some difficulty of vision, inability to concentrate thought, and insomnia. He went to the Atlantic seaboard for two months and the symptoms disappeared. After this he came to Colorado, October, 1877, with the same symptoms, and after a few days began to improve, and left in a month free from any trouble.

In these cases there was evidently no material change of structure or important complications.

Admitting the difficulty of comparing accurately the condition of these five cases during their early and later attacks, the last of which brought them to Colorado, they at least show that the fatigued brain and cord were not irritated, but soothed and rested in the pure mountain-air.

I regret that I cannot command for comparison any clinical reports of cases treated in ocean climates. I am, however, very strongly of the opinion, allowing the contraindications which have been suggested, that the larger proportion of cases of neurasthenia are most surely and quickly benefited by high climates. This opinion is formed from my observations in Colorado, and also in noticing the effect upon such patients who were sent from England to Alpine resorts. Where, however, there is but slight if any anæmia and much irritability, the sea-shore, or still better a sea-voyage, is more suitable. In choosing a climate for cases of chronic neuralgia or migraine the same general principles must guide us.

Epilepsy when not improved at the sea-shore is often benefited at an altitude, but it is always safer to try the more sedative climate first, and mere change will often make remedies of more avail in those cases which admit of improvement. Chorea is generally best treated in low climates.

Kidney Diseases.

Parkes demonstrates[1] that as the temperature of the air rises above 49 degrees the urea, chlorides, and other constituents of the urine decrease. In the Royal Society's *Transactions* for 1861 it is observed that the urea is lessened with severe cold, and Dr. Edward Smith's observations, made in England during an exceptionally cold year, proved that more urea is secreted in summer than in winter.

The British Government statistics and the observations of Dickinson, Morehead, Martin, Hyaltelin, and Chambers prove that renal disease is most common in temperate climates, and least so in cold ones, and, if the secondary or lardaceous cases are eliminated, rare in the tropics. The prevalence of the disorder in temperate climates may be explained, as Dickinson suggests, by the axiom that the liability of an organ to disease, particularly to inflammatory disease, bears a general proportion to its functional activity. The respiratory organs are more active in cold, the kidneys in temperate, the liver and bowels in hot, climates.

The statistics of the British army, taken for upward of eight years in all parts and all climates of the globe, confirm this by demonstrating that the prevalent diseases in Arctic climates are catarrhal affections of the respiratory tract; in temperate climates, tubercular and renal disorders; and within the tropics, dysentery, hepatitis, and malarial

[1] Parkes on *Urine*, p. 95.

fevers. Statistics show that a wide range of temperature with sudden changes increases renal disease; where the range is high, however, these variations do not increase the amount of the disease, but where it is low, it does so to a marked degree. Statistics also tend to exhibit the fact that dampness develops the disease, but as this element is so mixed with other factors, this point is not thoroughly demonstrated. It is, however, a matter of common observation, writes Dickinson,[1] that patients with albuminuria thrive better and prefer a dry bracing air to a damp relaxing one.

Dickinson further states that statistics prove that renal diseases chiefly abound where the mean annual temperature is not so far removed from fifty degrees, while in whatever direction we leave the temperate range we find albuminuria less common. In Iceland it is rare, and, going toward the warmer latitudes, excepting the lardaceous form, it diminishes as the temperature increases. He indicates further that with an equivalent temperature the dryer climate shows less kidney disease. Copland[2] enlarges upon the fact that the skin of the negro is a much greater and more elaborate apparatus for excretion than that of the natives of temperate and cold countries. In the white man, inhabiting the hot countries, he shows that the liver is larger and more active to supplement the comparatively deficient cutaneous action, while in temperate climates the kidneys more especially aid, and in cold climates the lungs still more.

All the observations referred to, however, dwell much upon the temperature and very little on the humidity, and this neglect of the consideration of humidity and temperature together is common to all but recent writers. Weber says: "The separation of water by the lungs and skin is diminished in great dampness and more work devolves upon the kidneys, while their activity is less called upon when the air is dry and warm; and we must always pay great attention to this in affections of the kidneys." He further writes: "As cold air contains less vapor than warm, therefore there is more loss of water by the lungs when the air is cold than warm." It is admitted that warm dry air relieves the kidneys by increasing the amount of water excreted by the skin, while the warmth, as opposed to the cold, rather decreases the excretion of water by the lungs. Why should not cold dry air also relieve the kidneys through the greater excretion of water by the lungs, compensating equally for the lessened excretion by the skin, and (as it has been shown that in the white races the lungs take more of the work of excretion upon themselves relatively than does the skin, and that in the body's economy the compensating power of an organ is

[1] *A Treatise on Albuminuria*, by W. H. Dickinson, M. D., W. Wood & Co., New York.

[2] "Climate," *Copland's Medical Dictionary*, Longmans, Brown & Green, London.

exerted, within reasonable limits, in proportion to its needs) it is rational to suppose that the increased activity of the lungs compensates exactly for the skin's deficiency, and that cold dry air relieves the kidneys as much as does warm dry air.

It must be admitted that theoretically a warm dry, equable climate is the ideal one to relieve the diseased kidneys at their work. But this is, as has been shown elsewhere, a combination of qualities which cannot exist in nature, for the reason that the dryer the climate the less the equability; with dryness comes relief to the kidneys by more evaporation from both lungs and skin; with dampness, on the other hand, less evaporation, but also less danger from changes of temperature; with warmth, more secretion from the skin and less from the lungs; and with cold, more from the lungs and less from the skin; with warmth, again, more prolonged outdoor life, and with cold more toning up of the general vitality. Thus whatever way we look we find that in one or other of the elements there is a falling short of the ideal standard of climate.

To pass from the theoretical to the practical consideration of the subject, beyond such opinions as I have quoted very little clinical evidence is furnished by the barren literature of this subject, and certainly nothing has been proven.

The Influence of Climate upon Bright's Disease.—As observations of the effect upon this disease of such an extreme climate as Colorado may tend to shed some light upon the probable influence of climates in which the conditions are more or less reversed, I will quote from a paper I wrote some seven years since:[1]

"During a general practice of nine years in Colorado Springs and Manitou, leaving out cases of lardaceous disease, I believe I have seen a smaller proportion of cases of Bright's disease than would be expected in most other localities.

"I remember but four cases of primary renal disease that I have treated, all of which came from the mountains. They arose from a great and sudden exposure. They were all relieved on being brought to this lower level, and, though seriously ill, all made good recoveries whilst here. It is usually believed that acute nephritis is not infrequent among miners and ranchmen in the mountains. Inquiries I made recently at Leadville from four physicians who had been in large practice there for several years by no means confirmed this opinion.

"Although I have examined the urine at some period during pregnancy in the majority of cases that have come under my care, I remember to have found albuminuria in a very few, and only in two were any further symptoms developed: one with slight œdema became

[1] "Bright's Disease of the Kidneys, as Influenced by the Climate of Colorado," by S. E. Solly, *Transactions Colorado State Medical Society*, 1884.

perfectly well after confinement; the second, with convulsions and abortion at seven months, had a mere trace of albumin and no casts, and no other symptoms two months after the miscarriage, when she left for the East.

"I have frequently examined the urine during convalescence from scarlatina, but only remember one case of Bright's disease in consequence of the fever. In this instance there had been exposure and neglect, and there was much dropsy. The case, however, made a good recovery, remaining in this climate. In practice in London previously I found albuminuria a common sequela of scarlatina. In our county society the opinion of my colleagues was that scarlatinal nephritis is decidedly rare in this district.

"Lardaceous disease of the kidney being systemic in origin, makes it impossible to separate the climatic influence upon the kidney from the antecedent disease, and therefore we will omit such cases as not being pertinent to our inquiry. As regards other cases of chronic Bright's disease, I do not call to mind any whose origin could be stated positively as occurring in Colorado. The only cases that seem to me that can be brought forward to illustrate the effect of the Colorado climate upon the progress of the disease are those where time has been spent during the recognized course of the malady both in this and another different climate. Of such cases I have notes of only four, nor do I remember any others showing contrary conclusions. I will therefore briefly report these four cases:

"Case 1. *Chronic Parenchymatous Nephritis.*—This patient first became aware of his disease two years ago, while on the Atlantic coast, through consulting a physican concerning a considerable swelling of the abdomen and feet. He continued to get worse for three weeks, when he came to Colorado, when I found he had ascites and general œdema, granular casts and blood in the urine, with 2 per cent. of albumin. He was treated with jaborandi, Turkish baths, Basham's mixture, and a milk diet, resulting in the removal of the dropsy and a general improvement. He remained in Colorado for a year, during which time he attended to his business, and several times walked as much as twelve miles hunting, and, except after an occasional cold or overwork, the albumin steadily diminished, so that on reaching the East it was found to be only one-twelfth of the bulk. He remained East three months, during which time he caught several colds. His general health while there was fair, though he did not feel vigorous. At the end of three months he returned to Colorado, when I found the albumin had increased to one-fourth the bulk. He remained in Colorado about nine months, and worked harder than ever at his business. During the fall, after getting wet wading for ducks, he had a considerable further increase of albumin, which afterward dropped

again, and on leaving for the East in the spring the albumin was again only one-twelfth of the bulk, with an occasional hyaline cast. Five pints of urine were passed in twenty-four hours. There was no œdema, and, except for being tired from business worry, his general health was better than it had been since the beginning of his illness. During this time he had kept to a milk and vegetable diet, with occasional relaxations, and had taken Basham's mixture most of the time. The weight increased a few pounds.

"Case 2. *Chronic Interstitial Nephritis.*—This patient had chronic catarrhal pneumonia, resulting in consolidation of the upper half of the upper lobe of the left lung. The disease was arrested before coming, and was non-progressive whilst here. The renal disease had been discovered about a year and a half previously, and was apparently the result of diphtheria. He reached Colorado in September, and remained until the following May. On arrival the albumin was one-fifteenth of the bulk of the urine, and no hyaline casts were found; amount of urine a little below normal. It was a more than usually windy winter, and it was the gentleman's custom to drive some three miles to a camp he had in the woods, and remain there until about three o'clock in the afternoon, eating his lunch and sitting in the open air or, when too cold, in a little cabin. The mornings were generally warm and still, but most afternoons he had to drive home through a cold wind. He had two slight attacks of pleurisy, but otherwise gained slowly, and on leaving was decidedly in better health. The urine was normal in amount—no casts, the albumin loss being one-twenty-fifth of the bulk. After his return he continued to live East, and died a year later from renal and other hæmorrhages after sudden exertion. The treatment in Colorado was merely general care.

"Case 3 was one of chronic parenchymatous nephritis, detected about six months previous to arrival while in the East, where he lived. There was no œdema or general debility. The record of the urine is lost, but there was a moderate amount of albumin with granular casts, and on leaving, after spending the winter, the percentage of albumin was decidedly less—very few casts, and little less than the normal amount of urine passed. He was on a milk diet. He returned East in more vigorous health, but the subsequent history I do not know.

"Case 4. Chronic parenchymatous nephritis, probably consequent on nervous shock from severe fall and injuries whilst living in the East, a year previous to coming to Colorado. This case was under observation, off and on, for three years, during which time he was chiefly in Colorado, especially during the first year and a half, but went across to Europe, and remained East during portions of the three years. When first seen there was 1½ per cent. of albumin, numerous granular and fatty casts, slight ascites, considerable œdema of lower

limbs, and much pain over kidneys. The treatment was a mixed diet, tincture of chloride of iron, alkaline waters, and dry cuppings. At the end of three years there was no trace of albumin or casts. The amount of urine passed was about normal, and the general health good. The patient continues well and lives East.

"Each of these four patients, in contrasting their experience of the climate of Colorado and that of the East, said that they found that they less often caught cold here than elsewhere, and that when they did so they got over a cold more quickly.

Healthy Kidneys.—"With regard to the effect of climate upon healthy kidneys, persons during the first few days after their arrival have frequently called my attention to the 'thickness' of their urine, which upon examination proved to contain an excess of solids, especially the urates. These persons have usually thought also that they passed perhaps less water, but certainly more frequently. This condition usually passed off in a few days, and the urine returned to its normal appearance. This would suggest that the excretion of water by the lungs and skin was much increased at the expense of the kidneys, at least on first coming; and this the parched skin would bear out.

"My friend, Dr. S. A. Fisk, informs me that from quantitative and qualitative analyses made by him upon specimens of urine taken from healthy persons who were permanent residents, the urine was normal, except perhaps the specific gravity being slightly higher. This would indicate that in healthy persons the balance between the excreting organs is in time regained.

"The points that seem to me suggested at this stage of the inquiry, though as yet nothing is established, are the following:

"First. Acute nephritis, like all acute inflammations, is not infrequent in Colorado, especially in the mountains, where the inhabitants, not being natives, are careless of climatic extremes, and that when occurring is, like all inflammations at an altitude, more than usually acute; that acute nephritis is not especially induced by the climate, but, having risen, is in its outset aggravated by it.

"Second. The direct tendency of the climate in chronic nephritis, as in most chronic diseases, is toward its cure. This beneficial influence is mainly exerted through the increased action of the lungs, and to a less extent of the skin, affording relief from work by the kidneys, and by the general stimulating and equalizing of the circulation, lessening the renal congestion."

My observations during the past five years following the time of this report tend to confirm these conclusions. Cases 1 and 4 are still alive and well: the former lives East, and was seen by me a few months since, and the latter has returned here and does business. A case of chronic interstitial nephritis consequent upon typhoid fever came to

Colorado four years ago in poor general health, and with a few casts and a little albumin in the urine; she improved very much in her general condition, the analysis of urine remaining relatively about the same and the amount not further diminishing. She died, however, a few months since from pneumonia following a second attack of typhoid fever. This case shows that the progress of the disease, while it may not have been retarded, was not accelerated by residence at an altitude.

Sir Andrew Clark stated to me that he found that kidney affections were frequently developed among the consumptives residing in the High Alps. I do not know what was the exact nature of their disease, and I have been unable to ascertain what is the average percentage of cases of lardaceous kidney among consumptives generally. In 150 cases of phthisis which I treated in Colorado and traced up there were 4 with this complication—2 who were affected before coming to Colorado, and 2 since. In all of the patients the urine was frequently tested. It is quite common in Colorado to find in fatal cases at the last more or less œdema, but the test-tube and microscope often fail to show any renal affection; doubtless the œdema is due to the weakening heart. I believe that the somewhat prevalent opinion of the frequency of lardaceous kidney in Colorado is due to this œdema being present and no test being made. With respect to nephritis, acute or chronic, among the 150 consumptives referred to there were 3 cases. Two began in Colorado—one acutely, the other slowly. The former, who showed unmistakable evidence of a tuberculous kidney, is still in Colorado and much improved, though he has a little albumin and a few casts. The latter case died of his pulmonary disease with increase of the renal symptoms.

In the present state of our knowledge it is undoubtedly safest to try a warm climate first, which may have a high humidity, but must have a moderate rainfall. The age of the patient should much influence the choice between a warm and a cool climate, and also the stage of the disease; and whether it is reasonable to look for cure or only alleviation of the malady is a most important point.

Diabetes, both mellitus and insipidus, would appear not to be diseases *per se*, but symptoms resulting from disturbance of the functions, or change in the structure of, some portion of the nervous system or of one or more of the digestive organs, notably the liver. Change of climate, though not usually of the first importance in the treatment of this disease, is often an aid to other therapeutic measures. The choice must then be determined by the primary causes of the affection, as, for instance, when the cause appears to be too high living in a full-blooded person, a low unstimulating climate at a spa, such as Carlsbad, where the waters are rich in the salts provocative of increased metabolism, is indicated. When, again, digestive or excretory causes are at the root

of the matter, and the patient is of the anæmic type, the mountains are of the most avail. Where the nervous system seems most to blame, and when an actual lesion is suspected, a warm sea-shore is generally indicated, while in cases in which the nervous symptoms are functional and more or less anæmia is present, elevated climates will probably do more to retard or cure. I have watched with interest the progress of several cases of diabetes while they resided in Colorado, but have been unable so far to come to any conclusions on the influence of altitude upon the disease.

Hepatic Affections.

Where there is evidence of a serious organic lesion the only change of climate admissible would be a comparatively negative one. In functional disturbance, on the other hand, climatic change of a positive character, as from sea to mountain or *vice versâ*, is often of the greatest benefit. The direct influence of climate is perhaps more marked upon the functions of the liver than on any other organ. Speaking broadly, persons may be divided into those who are made bilious by going to the sea-shore, and those upon whom the mountains have a similar influence. It will be found, as a rule, that with fair and full-blooded persons the liver acts best on the sea-shore, while with the dark-skinned and anæmic in mountain-air the hepatic functions are the most regular. The question is, Do the nervous or circulatory systems call for a sedative or stimulating tonic quality in the air to provoke or regulate the necessary metabolism and thus bring back health? Dr. Weber and other writers on climatology have spoken of the favorable influence of elevated climates upon sluggish circulation in the abdomen generally, and so it has appeared to me that passive congestions in anæmic persons were usually benefited at an altitude, while it failed to agree with the full-blooded or those in whom there were active congestions or marked nervous irritability.

Attacks of Gall-Stone.—To remove the conditions upon which the formation of gall-stones is dependent certain drugs are generally called for, notably sulphate or phosphate of sodium, and clinical experience indicates that these are of most avail when administered in a natural mineral water. A suitable spa should therefore be sought, but to get the best effects one should be selected in a climate that is best suited to the patient upon the general principles already laid down. The success or failure of treatment at Carlsbad is undoubtedly mainly due to these general principles. As balneotherapy does not lie in the range of this article, I cannot well pursue the subject further, but I may mention that I have been much gratified by the prompt results in the treatment of gall-stones by the use of the Shoshone Spring at

Manitou, Colorado.[1] Some of the cases had previously been treated at Carlsbad with very imperfect results. The Manitou spring is very much less rich in the requisite salts, and often requires an artificial addition; I cannot therefore but believe that the climate as well as the spring is often not sufficiently considered.

Affections of the Stomach and Bowels.

Very little can be said about the influence of climate upon such disorders, except to follow the general principles laid down concerning other diseases, and to fit the climate to the individual rather than to the disease. Temperature has, as has been elsewhere pointed out, the most marked influence upon the secretion from the intestines. As a generality, it is true that a hot climate provokes diarrhœa and a cold one constipation; while as regards the effect of humidity, though it tends to increase the amount of diarrhœal affections, yet where heat is present in spite of the absence of humidity not a little diarrhœa and dysentery is found, though seldom of as grave a character as in warm damp climates. The cause is probably in the marked change between day and night, sunshine and shadow. Cases of chronic diarrhœa and dysentery and chronic dyspepsia, as well as chronic ulcers of the stomach and duodenum, which have arisen while the patients were residing in low climates, and which the best therapeutic measures at home have failed to cure, will frequently recover under similar treatment if they remove to an altitude; and, on the other hand, I have known cases arising in Colorado, which have become chronic, that were quickly benefited by a change to the sea-shore.

Conclusion.—We have now travelled over the main routes which open up the field of climatotherapy, and have endeavored to exhibit the general principles, though not the details, of the subject. The scientific study of climatic therapeutics may be said to be in its infancy, and although the literature of the subject is abundant and is enriched by valuable works, such as those of Weber, Lombard, Hirsch, and others, yet the grains of wheat among the chaff are comparatively few and widely scattered. Most writers in describing the effects of a particular climate write empirically, but without having first studied the known facts and general principles of climatology, and do not connect their fragmentary studies with the general subject, and do not even give logical reasons for their statements where other proof cannot be obtained. Verbose or poetical descriptions of scenery or glittering generalities fill out the most of such articles, and a claim for therapeutic virtue in the particular climate for the most opposite pathological conditions is made, the writers failing to recognize that the more positive the

[1] See *Manitou, its Mineral Water and Climate*, by S. E. Solly, M. D.

climatic effect in one direction, the more positive it is also in the other; in short, that a shield has two sides. When we come to clinical statistics we realize the poverty of the literature and how rich a stream of knowledge is flowing away in thousands of health-resorts all over the world. Of course it is the quality and not the quantity of the records that is wanted, and the careful following up and recording of cases is attended in all chronic diseases with especial difficulty and demands much time and labor. The neglect to record clinical results, especially among those most interested—viz. specialists who send to, and the local physicians who care for, invalids at health-resorts—is very great. This is markedly shown in the comparatively few records of phthisis I have been able to present, only obtaining fifteen sets of statistics. However, there is now awakened a much greater interest than ever before in the whole subject of climatology, and we may look with hope to the future; in the mean time we must speak without dogmatism or extravagance, and learn the lessons that the few facts we have can teach us before we speak at all. In selecting a climate for an invalid let us above all remember to examine not only into the suitable application of the climatic factors to the disease, but also into the peculiarities of the individual and his attendant circumstances.

MINERAL WATERS AND THEIR MEDICINAL USES.

By JAMES K. CROOK, M. D.

A BRANCH OF THERAPEUTICS MUCH NEGLECTED BY THE PROFESSION AT LARGE.

At a recent anniversary banquet of one of our great medical associations eight or ten well-known physicians sat at one of the smaller tables in the great dining-hall. Among the fluid refreshments appeared several varieties of popular commercial mineral waters. One of the party banteringly asked a neighbor to give him the analysis of the water he was at that moment sipping. He was obliged to confess his ignorance. Nor was he sure that he could name a single chemical constituent of the water. No one at the table could enlighten him. In the general discussion relating to mineral waters which ensued the fact was developed that the information relating to this particular subject was neither broad nor deep. Scarcely one of the group knew more than the names of several of the better-known American mineral spring resorts, although, as most of them had taken pleasure-trips to Europe, they could mention in a general way the names and locations of several of the continental spas. But as to any practical knowledge of the different varieties of mineral waters, their uses in the therapeutic art, or as to accurate information concerning our American spring localities, their advantages as health resorts, etc., it is no exaggeration to say that these little matters had no existence at this festive board. Yet, almost without exception, these gentlemen belonged to what might be termed the aristocracy of the profession. They were men of superior intelligence, and were nearly all teachers in widely-known medical schools, whose duty it was to instruct students as well as other medical men in the noble art of healing the sick. This is not a pleasing commentary on the breadth and scope of learning among American practitioners concerning an important and useful department of clinical medicine. Yet the doubting inquirer may soon convince himself that the facts are not overstated. But a more discouraging aspect of this question is the fact of the extreme indifference to the subject manifest among medical

men. The author has in mind a recent case illustrating this lukewarmness. A physician who had spent many years in an honest scientific study of the therapeutics of mineral waters, and had prepared a short practical paper on the present-day use of these agents, was refused a place on the programme of one of our great State medical conventions on the ground, as he was informed, that the subject was "not of sufficient importance." Is it not time that this branch of therapeutics was rescued from the hands of quacks and empirics, who have so long held it practically unchallenged?

We must hold the absurd and ridiculous claims made by many spring advertisers responsible for a large share of the distrust and prejudice among medical men which are so apparent in our country. It cannot be successfully denied that the waters which issue from the earth charged more or less abundantly with chemical ingredients of proved therapeutic utility have a useful and valuable place in scientific medicine. Hippocrates himself was a believer in mineral waters, a fact of which abundant proof exists in his writings. And in every age of the world since that illustrious master flourished we find the names of honored and trusted men not actuated by self-interest advocating their rational use, amid the quacks and charlatans who have clogged the wheels of progress. These natural resources exist in every State of our broad land. More than two thousand mineral spring localities, embracing upward of ten thousand springs, are known to exist in the United States. In this vast list will be found the close counterparts of the best mineral waters of Europe, which have had the sanction of the most eminent medical men of Germany, France, and England for centuries. Instead, therefore, of scoffing at these cheap and abundant therapeutic aids, would it not be better if the educated profession of the United States gave some really serious and concerted attention to their resources and possibilities? The waters of our own country issue from the same earth as do those of Europe, the springs are surrounded by scenery as delightful and a climate as salubrious, and during recent years comfortable—even luxurious—hotels, bathing-houses, and other adjuncts have been added to Nature's attractions. There is no practitioner of medicine in the United States who, if he possess the requisite knowledge, will not find it of advantage to himself and to his patients to make occasional use of some of these spring localities or of the waters brought from them. Then let educated physicians consent to encourage this branch of study. Let papers be read and discussed before our medical societies, and let articles be published in our medical journals dealing with the subject in a broad and scientific spirit. Let the professor of therapeutics or of the practice of medicine in our medical schools give at least one or two lectures

during each term to the consideration of mineral waters and spa treatment, and let some knowledge of balneo-therapeutics as well as of climato-therapeutics be made essential to the issuing of a diploma of graduation. Every one has observed the speedy improvement in general health usually manifested in persons sojourning at mineral springs during the summer. This is, no doubt, to some extent due to the pleasing scenery and the bracing country air of those localities, as well as to a change of surroundings and escape from the cares and anxieties of home and business. Yet, after a liberal deduction for all of these influences, a large share of the good results may still be justly attributed to the aid of a properly selected mineral water.

ON SENDING PATIENTS TO MINERAL SPRINGS.

THE observing medical visitor at almost any of our well-known American spas during the season will be struck by the great proportion of persons who are daily consuming large quantities of the spring water for real or imaginary ills entirely on their own responsibility. It is doubtful whether more than one individual in ten at most of our spring resorts is acting under the guidance of a physician. In cases where the disorder is slight or the waters lightly mineralized no harm is done; but there is a not inconsiderable class of patients whose physical conditions are distinctly deteriorated by the indiscriminate drinking of strong waters. No one who wishes to take such a course of treatment should ever begin it without first consulting a reputable physician as to the advisability of such a step, and as to where he should go and what water he should drink. And the physician on his part should be prepared to give his patient sound and useful directions. Let him first decide for the patient whether or not his condition is one requiring a change of surroundings and climate or a course of spa treatment. The practitioner should know something of the locality of the springs to which he proposes to send his patient. He ought to possess information concerning the routes of travel and the variety of accommodations at the spa, the scenery and surroundings, the height above the sea-level, and, above all, the chemical character and constituents of the mineral water he proposes to have his patient drink or to bathe in. He should then give the patient a letter to the resident physician at the spa with full details as to the nature, previous treatment, and recent progress of the case. If such simple and perfectly feasible directions were the rule in the United States, instead of the rare exception, this important form of treatment with us would soon reach something of the

dignity and importance it has long held in Europe. A few additional precautions to the patient before he sets out on his journey may be advisable. Direct him on arrival at the spring to obtain explicit instructions from the resident physician as to when to drink the waters, in what quantities, or, if bathing is to be employed, the temperature of the water, the length of time of each bath, and their frequency; and also exact instructions as to diet, gymnastics, outdoor exercise, massage, douches, etc. The season at mineral springs in the United States, as in Europe, is very short, beginning generally in June and ending in October, the rates at hotels, sanatoria, etc., being generally somewhat lower early and late in the season than when it is at its height. It sometimes happens immediately after reaching a spa that slight digestive disturbances, especially constipation or diarrhœa, will be observed for a day or two. This may be due to some extent to change of food or the excitement of the journey, but may often be attributed to the character of the water. A very minute proportion of the sulphate of sodium or magnesium will cause free alvine evacuations in beginners, while the calcareous, the aluminous, and some of the chalybeate waters are liable to cause temporary constipation. On going to a high altitude, like the Glenwood Springs of Colorado or the Hot Springs of Virginia, it is well for delicate persons to take along abundant wraps or some warm underclothing even in the middle of the summer. The patient should be enjoined from entering with too much zest into the enjoyments of the place. A little too much dancing, tennis, bowling, rowing, or even progressive whist and euchre, in many cases serves to render nugatory the expected benefit of a stay at a watering-place.

HOW DO MINERAL WATERS ACT, OR IN WHAT WAY ARE THEIR GOOD RESULTS BROUGHT ABOUT?

THESE questions can usually be readily answered after a study of the chemical analysis of the water. It is very apparent that a water heavily charged with the sulphate of magnesium or potassium will cause evacuations from the bowels, or that one containing iron in appreciable quantities will increase the hæmoglobin of the blood. But the analysis does not always account for the effects shown by the water. It is well known that the light arsenical waters will quickly give rise to the well-known physiological symptoms produced by arsenic even though that powerful agent be present in much smaller quantities than we would prescribe in the pharmaceutical preparations. Nor can we obtain these same effects by artificially adding arsenic to

water. Some of the iodo-bromated waters of Europe were known to be efficacious in the later manifestations of syphilis for many years before the analytical chemist discovered the presence in them of the iodide of potassium in minute quantities. It is also well known that a very few grains of the carbonate of calcium to the gallon will greatly increase the diuretic action of water, while, as before mentioned, an exceedingly attenuated saline sulphated water used habitually will promote regularity or even cause looseness of the bowels. It may be said, then, that while the action of a majority of mineral waters may be explained by the ingredients they contain, we must confess that the good effects of many of the lighter waters cannot be so accounted for, and knowledge concerning them is based largely on observation and experience with them. As Professor Oscar Liebreich has observed,[1] the analysis, even when made by the most careful chemist, does not always account for the full 100 per cent. of contents, but leaves a very large x unaccounted for, of whose nature we have no idea. We prescribe mineral waters on account of their most prominent ingredients, but we cannot be perfectly sure, as Hermann Weber remarks,[2] that the substances present in smaller quantities do not play a more important part in the physiological action of the whole water than we generally concede to them.

ON THE CLASSIFICATION OF MINERAL WATERS, WITH OBSERVATIONS ON THEIR THERAPEUTICS.

It is important for us to know how to designate a given mineral water when we see its analysis, and to this end some standard form of classification should be adopted. Many different schemata for this purpose have been recommended by almost as many writers. After a careful examination the author has concluded that the classification proposed by Dr. Albert C. Peale, of the U. S. Geological Survey, has fewer objections and possesses certain advantages over all others. This scheme is altogether comprehensive, and is applicable not only to the waters of the United States, but to all others no matter whence they may come. With certain modifications by the author, this classification is as follows: All mineral waters are divided primarily into two great groups: (A) Non-thermal or Cold Waters; and (B) Thermal Waters; and are then treated precisely alike as to their mineral ingredients.

[1] Address before German Balneological Congress, 1893.

[2] Allbutt's *System of Medicine*, vol. i., 1896.

Scheme of Classification.

Group A. Non-thermal or Cold Springs.
Group B. Thermal Springs.

Class I.	Alkaline	Sulphated, Muriated.
Class II.	Alkaline-saline	Sulphated, Muriated.
Class III.	Saline	Sulphated, Muriated.
Class IV.	Chalybeate	Alkaline or Saline.

Class V. Neutral or Indifferent Waters.

Any classification must, from the nature of the case, be somewhat arbitrary. Nature herself is an evolution, and we find that waters so shade into each other that it is difficult to draw hard-and-fast lines. The above classification, however, admits of a ready subdivision according to the solid constituents as follows:

1. Sodic.
2. Lithic.
3. Iodic.
4. Arsenical.
5. Acid.
6. Aluminous, etc.

The existence or non-existence of gaseous contents may be thus expressed:

I. Non-gaseous.
II. Carbonated or Acidulous, containing carbonic acid gas.
III. Sulphureted, containing hydrogen sulphide.

The waters of any of the groups mentioned above may be more or less abundantly charged with one or both of these gases, and this fact may be recognized in referring to the water. We thus speak of alkaline or saline carbonated waters, or of saline sulphureted or sulphureted chalybeate waters. If a spring is densely charged with solid or gaseous contents, it is spoken of as "heavy" or "strong," as a strong alkaline, a heavy chalybeate. If feebly mineralized, it is denominated "mild" or "light," as a light carbonate or a mild saline, etc. The designation of a water according to this scheme allows the practitioner at once to get a definite idea of its general chemical composition, and to obtain a view of its probable medicinal value, after which a more detailed study of its analysis will enable him in a large measure to determine whether or not it is likely to meet the indications of any particular case.

Alkaline Mineral Springs.

The alkaline mineral springs include all those which are characterized by the presence of the alkaline carbonates, as the alkaline earths, the carbonates of the alkalies, and the alkaline metals in

preponderance. Generally, these waters are further distinguished by the presence of carbonic acid gas, and may thus be additionally designated as carbonated. Those containing an excess of this gas have an acid reaction when first drawn, and an acidulous, pungent, but very agreeable, taste. It gives to water a bright and piquant sparkle, and is the gas used in charging all of our synthetic commercial waters—seltzer, soda, Vichy, etc. It is also present in many wines. In moderate doses carbonic acid promotes the flow of saliva, tends to allay nausea and gastric irritability, aids digestion, assists in rendering the fluids of the body alkaline, promotes diuresis, and imparts a sense of well-being. The carbonic-acid waters are often better borne by the stomach than any other kind of drink, and they supply a pleasant medium for the administration of milk to fever patients. When associated with the alkaline carbonates, carbonic acid greatly increases their solubility, forming with them the bicarbonates. It is these salts which give character to alkaline mineral waters. They consist of the carbonates of calcium, lithium, potassium, magnesium, sodium, and iron. These compounds have so many characters in common that it seems proper to consider them in one group, afterward noticing their individual properties. The alkaline carbonated waters stimulate the action of the stomach, render the urine alkaline, increase its flow, and are diaphoretic in some degree. They are not purgative unless combined with salines, and have a tendency to lessen catarrhal discharges. They form a very efficacious and speedy remedy in the treatment of acid dyspepsia and flatulence. Given before meals they act as stomachics by stimulating the peptic glands. When dyspepsia is a simple, idiopathic disorder it is generally very thoroughly relieved by one of the alkaline carbonated waters. Though not curative, they are useful in ameliorating some of the symptoms of gastric cancer, chronic catarrhal gastritis, and cirrhosis of the stomach. Having a diuretic tendency, the habitual use of the alkaline waters serves to correct acidity of the urine, and is of great service in fevers, gout, rheumatism, vesical irritation, and for some of the symptoms of diabetes mellitus. When combined with salines, forming the great alkaline-saline group of waters, their sphere of therapeutic usefulness is greatly extended. They also assume new properties when associated with iron, constituting the highly prized alkaline chalybeate waters.

Carbonate of Calcium.—This compound possesses properties not observed in the other carbonates. Although alkaline in reaction, it is not evacuant, but rather constipating in its effects on the bowels. In virtue of this action the calcic alkaline waters have been used with much success in chronic diarrhœa. There are reasons for believing that uric acid gravel and calculi may be disintegrated and eliminated under their free use.

Carbonate of Lithium.—This salt is sparingly, and the bicarbonate freely, soluble in water. Solutions of lithia are decidedly alkaline. These compounds are found in various proportions in a considerable number of our mineral waters. Lithia owes its virtues to the fact that it unites readily with uric acid, forming the urate of lithium, a freely soluble compound which passes readily from the system. For this reason it finds its most important application in diseases characterized by the uric acid diathesis, otherwise known as uricæmia, lithæmia, or lithiasis. The lithia waters are notably useful in conditions marked by the presence of uric acid sand, gravel, and calculi, and in gout and rheumatoid arthritis.

The **carbonate of magnesium** is perhaps the most efficient of the antacids. It is mildly alkaline in reaction. In mineral waters its best effects are shown in acid eructations and pyrosis, and in sick headaches, especially when due to or accompanied by constipation. It is also useful in checking the formation of uric acid concretions and calculi.

Carbonate of Potassium.—This salt is usually found in mineral waters in the form of the bicarbonate. It possesses antacid, diuretic, and antilithic effects in connection with other alkalies, but claims no individual or peculiar virtues.

Carbonate of Sodium.—This may be taken as the standard of the alkaline carbonates formed in mineral waters. It occurs with greater frequency, and as a rule in larger quantities, than the other salts of this character. Waters containing it may be used whenever an alkaline water is indicated, as it possesses most of the virtues of the group. Muriated and sulphureted alkaline waters will be discussed in a later paragraph.

American Alkaline Springs.—The following analysis of the Allouez Mineral Springs, of Green Bay, Brown County, Wisconsin, presents a very good example of a fairly potent alkaline mineral water. One U. S. gallon contains:

Solids.	Grains.
Magnesium bicarbonate	27.53
Calcium bicarbonate	24.69
Iron bicarbonate	0.06
Sodium chloride	4.26
Sodium phosphate	trace
Sodium sulphate	3.46
Potassium sulphate	0.12
Calcium sulphate	0.11
Alumina	0.17
Silica and insoluble residue	1.97
Total solids	62.37

No carbonic acid gas is mentioned in the analysis, but we know it

exists in the water because of the presence of the bicarbonates. We observe also the presence of several saline ingredients, but they are not in sufficient quantity to modify materially the general alkaline character of the water. Hence it is properly termed an alkaline water, or, if we choose, an alkaline magnesic or magneso-calcic water. These springs are quite numerous in the United States, the following being among the most potent American alkaline waters. The figures have reference to the number of grains of solid contents per U. S. gallon of 231 cubic inches:

Alabama: Bladon Springs, Choctaw County, 67.28.

Arkansas: Ravenden Springs, Randolph County, 21.82.

California: Adams Springs, Lake County, 201.19. Ætna Soda Springs, Napa County, 134.05. Bartlett Springs, Lake County, 43.34. Blodgett Springs, Santa Clara County, 44.13. California Seltzer Springs, Mendocino County, 187.15. Duncan Springs, Mendocino County, 118.11. Highland Springs, Lake County, the "Dutch" or "Ems" Spring, 156.86. Uriah Vichy Springs, Mendocino County, 268.45.

Colorado: Manitou Springs, El Paso County, the "Navajo" Spring, 182.23.

Idaho: The Idanba Spring, Bannock County, 152.06.

Illinois: Magnesia Spring, Kane County, 38.92. Perry Springs, Pike County, "No. 2," 40.17.

Iowa: Siloam Springs, Hardin County, 32.35.

Kansas: Arrington Mineral Springs, Atchison County, 43.58.

Michigan: Eastman Mineral Springs, Berrien County, "King David" Spring, 14.55. Leslie Well, Ingham County, 63.01. St. Louis Spring, Gratiot County, 227.14.

New Hampshire: Londonderry Lithia Springs, Rockingham County, 74.85.

New York: Glen Springs, Schuyler County, the "Seneca" Spring, 12.66.

North Carolina: Bromine-Arsenic Springs, Ashe County, 5.45.

Pennsylvania: Ponce de Leon Springs, Crawford County, 20.86.

Tennessee: Glenn Spring, Tipton County, 20.73.

Virginia: Buffalo Lithia Springs, Mecklenberg County, 98.36. Colemanville Mineral Springs, Cumberland County, 19.41. Nye Lithia Springs, 18.54.

Washington: Medical Lake, Spokane County, 101.45.

West Virginia: Berkeley Springs, Morgan County, 10.88. Capon Springs, Hampshire County, 12.14. Old Sweet Springs, Monroe County, 60.62.

Wisconsin: Arctic Mineral Spring, Trempeleau County, 25.03. Hackett Springs, Milwaukee County, 17.70. Palmyra Mineral

Springs, Jefferson County, 28.74. Waukesha Mineral Springs, Waukesha County, the "Hygeia" Spring, 36.21.[1]

European Alkaline Springs.—Springs of this character do not appear to be so numerous in European countries as in the United States, but the better-known ones are somewhat more heavily mineralized than are our own of the same class. The following is an analysis of the famous "Grande Grille" Spring of Vichy, France. One United States gallon contains:

Solids.	Grains.
Sodium carbonate	208.00
Potassium carbonate	16.32
Magnesium carbonate	11.04
Calcium carbonate	18.48
Ferrous carbonate	.16
Manganese carbonate	trace
Strontium carbonate	.08
Sodium chloride	32.80
Sodium borate	trace
Sodium arseniate	.08
Sodium sulphate	18.32
Sodium phosphate	6.24
Silica	.40
Total solids	311.92
Carbonic acid gas	117.92 cubic inches.

The following are celebrated springs of this type: Apollinaris Springs, Neuenahr, Rhenish Prussia, 157.76 grains per United States gallon; Bilin, Bohemia, "Joseph Quelle," 304.49; Alkaline Spring at Carlsbad, Bohemia, 55.16; Ems on the Lahn (Kessel-Brünnen), 169.75; Fachingen, Nassau, Germany, 223.51; Geilnau, Hesse, Germany, 124.07; Geisshuebel (near Carlsbad), Bohemia, 86.58; Holy-well, North Wales, 29.65; Obersalz-Brunn, Silesia, 138.08; Desirée Spring, Vals, France, 535.88; (Victoria-Quelle) Neuenahr, Rhenish Prussia, 158.64; Weilbach, Hesse, Germany, 165.27; Wildungen (Stadt-Brunnen), Waldeck, Germany, 67.44.[2]

Saline Mineral Waters.

This class of waters includes those in which the chlorides predominate. They also often contain more or less of the alkaline carbonates, and may contain iron, alum, sulphureted hydrogen, carbonic acid gas, etc. It is in these waters that the rare ingredients of iodine and bromine are occasionally found. The chlorides and sulphates are

[1] For a complete account of the American mineral springs, *vide* the author's recent treatise on the *Mineral Waters of the United States*, pp. 83–588. Lea Brothers & Co., 1899.

[2] For a full account of European mineral springs, *vide The Mineral Springs and Health Resorts of Europe*, by Herman Weber and F. Parker Weber. London: Smith, Elder & Co., 1898.

often combined in one spring, but as a rule one or the other group is so preponderant as to overshadow all other constituents. It would seem well, therefore, to consider the saline waters in two groups: (1) the muriated salines and (2) the sulphated salines. The muriated saline waters owe their activity to the presence of the chlorides, which occur in about the same combinations as do the carbonates, viz., the chlorides of sodium, potassium, magnesium, lithium, calcium, and iron. The chloride of sodium is the most universal of all the salts, and it is found in almost all mineral waters from mere traces to many thousand grains per United States gallon. It is one of the essential components of the body, being found in every structure except the teeth. We cannot here enter into an account of its various functions in the body; suffice it to say that it is one of the most important factors in the process of nutrition, and its withdrawal is at once keenly felt. The muriated saline or chloride of sodium waters when taken into the stomach in therapeutic doses cause an increase in the flow of gastric juice, bile, pancreatic juice, and intestinal fluid, promote the appetite, and aid the process of digestion. They have a mildly aperient effect, and exert an antiseptic influence on the intestines, tending to prevent putrefactive changes. They promote tissue-metamorphosis, as shown by an increase in the quantity of urea excreted. The mucous secretion of the bronchial tubes is also increased. In virtue of their physiological action the muriated sodic waters are of great value in gastric, hepatic, and intestinal disorders. It would be difficult to mention a chronic affection involving the stomach, liver, or intestinal tract in which one of the muriated salines could not at some stage be beneficially exhibited, and their good effects are often greatly enhanced by the presence of valuable alkaline ingredients, as well as iron. According to Herman Weber,[1] they are to be preferred even to the bitter or sulphated saline waters in frontal congestion in thin or spare persons, in whom emaciation is to be avoided. Their special application, however, is to be found in atonic dyspepsia, insufficiency of the digestive fluids giving rise to dry, scybalous stools, a furred tongue, disagreeable taste in the mouth, loss of appetite, hebetude, and malaise. These waters are also applicable to some extent in chronic bronchopulmonary affections with a tenacious, scanty expectoration. (The local use of the chloride of sodium waters will be referred to under Baths.)

The chloride of lithium is found in several springs in small amount, but appears to possess no therapeutic properties aside from those referred to under the carbonate of lithium.

The chloride of magnesium is a frequent component of muriated

[1] Allbutt's *System of Medicine*, vol. i., p. 323, 1896.

waters. It forms the bittern of salt-works and occurs in great quantities in the waters of the Dead Sea and in some of the brines of New York and Michigan. This substance promotes the flow of bile, acting mildly as a purgative and increasing the appetite.

Chloride of potassium coexists in many mineral springs with the chloride of sodium, though in much smaller quantities. Its functions and distribution in the body appear to be quite similar to those of its sodium component.

The properties of the chloride of calcium are much like those of the carbonate. The chloride of iron will be referred to under chalybeate waters.

Muriated Saline or Chloride of Sodium Springs.

The muriated saline waters of the United States are exceedingly numerous and excel those of any other country for richness in mineral ingredients and potency of therapeutic properties. The following analysis of the Wasatka Mineral Spring of Salt Lake County, Utah, shows a good example of this type of mineral water. One U. S. gallon contains:

Solids.	Grains.
Sodium chloride	230.88
Potassium chloride	3.06
Magnesium chloride	21.24
Calcium chloride	11.92
Lithium chloride	0.12
Ammonium chloride	0.25
Calcium sulphate	59.50
Calcium carbonate	4.75
Sodium borate	traces
Magnesium bromide	"
Silica	0.75
Iron and aluminium oxide	0.03
Total solids	332.50

Other valuable muriated saline springs of the United States are as follows:

Alabama: Livingston Artesian Well, Sumter County, 312.55 grains to the U. S. gallon.

California: Byron Springs, Contra Costa County, "Liver and Kidney" Spring, 769.05 grs.; Byron "Surprise" Spring, 18,773.73 grs. (undoubtedly the most heavily charged mineral water known); Calistoga Springs, Napa County, 41.98 grs.; Eureka Springs, Humboldt County (also sulphated), 1800.27 grs.

Indiana: Lodi Artesian Well, Fountain County, 672.45 grs.; Magnetic Mineral Spring, Vigo County, 429.36 grs.

Kentucky: Louisville Artesian Well, Jefferson County, 915.47 grs. (also sulphated).

Kansas: Geuda Springs, Cowley County, 1314.78 grs.

Kentucky: Olympian Springs, Bath County, 332.84 grs.; Upper Blue Lick Springs, Nicholas County, 660.14 grs.

Michigan: Clark's Red Cross Mineral Well, Mecosta County, 17,825.27 grs. (an exceedingly heavy brine, but used therapeutically internally and externally); Clark's Riverside Mineral Springs, Wayne County, 7318.97 grs. (also sulphated); Fruit-port Well, Muskegon County, 703.13 grs.; Grand Haven Mineral Spring, Ottawa County, 608.89 grs. (also sulphated); Mineral Well, Mt. Clemens Mineral Spring, Macomb County, 13,654.33 grs.; Spring Lake Well, Ottawa County, 628.37 grs.; St. Clair Mineral Spring, St. Clair County, 17,904.60 grs.

Missouri: Blue Lick Springs, Saline County, 610.30 grs. (also sulphated); Sweet Springs, Saline County, "Akesion" Spring, 1061.94 grs.

New York: Glen Springs, Schuyler County, "Neptune" Spring, 10,503.08 grs. (also iodo-bromated; used for Schott-Nauheim bathing).

Ohio: Cincinnati Artesian Well, Hamilton County, 617.32 grs.; Erkenbrecker's Salt Well, Hamilton County, 5738.10 grs.

Pennsylvania: Parker Mineral Springs, McKean County, 627.59 grs.

West Virginia: Addison Sulphur Springs, Webster County, 467.30 grs.

Wisconsin: Sheboygan Mineral Well, Sheboygan County, 436.49 grs.

European Muriated Salines.—The following is an analysis of a representative European muriated saline water. Kissingen (Pokoczi), Bavaria. One U. S. gallon contains:

Solids.	Grains.
Sodium chloride	357.68
Potassium chloride	17.60
Magnesium chloride	18.64
Lithium chloride	1.20
Sodium iodide	trace
Sodium bromide	0.48
Sodium nitrate	0.56
Magnesium sulphate	36.00
Calcium sulphate	23.92
Calcium phosphate	0.32
Calcium carbonate	65.12
Ferrous carbonate	1.92
Silica	0.72
Total solids	524.16
Carbonic acid gas	334.16 cubic inches.
Ammonia	.57 " "

Among other prominent European springs of this class are the following: Bareges (Boucheries), Hautes-Pyrénées, France, 10.32 grains per U. S. gallon; Cheltenham, England, 644.00; Homburg, Hesse, Germany (Elizabeth-Brunnen), 870.96; Harrogate, England, 864.43; Kreuznach, Rhenish Prussia (Oranien-Quelle), 1084.32; Springs of Nauheim, Germany (Friedrich Wilhelms-Quelle), 2148.07; Wiesbaden, Nassau, Germany (Koch-Brunnen), 507.70.

Sulphated Saline Waters.

The sulphated saline or purgative waters owe their chief virtues to the presence of the sulphate of magnesium (Epsom salt) and the sulphate of sodium (Glauber's salt). They usually contain other sulphates, also iron, calcium, etc., and frequently sulphureted hydrogen. The sulphate of magnesium occurs when isolated as a transparent crystalline salt, bitter, nauseous, and saline to the taste and exceedingly soluble. It is the important constituent of the so-called "bitter" waters. The sulphate of sodium is a white crystalline powder; also bitter and rather nauseous to the palate. It is freely soluble in water, and in variable quantities is a very frequent constituent of mineral springs. Both of these salts are laxative or purgative in effect, according to the dose taken. They act by promoting the process of endosmosis and exosmosis, thus abstracting the watery elements of the blood and increasing intestinal secretion. The observations of Rutherford and Vignal show that the sulphate of sodium is also a valuable hepatic stimulant, the action of the magnesic salt appearing to be limited chiefly to the intestinal glands. It is quite remarkable how small a proportion of these salts is required to give a natural mineral water laxative properties. Both are diuretic. The sulphate of iron will be considered under the chalybeate waters.

Therapeutics.—The best effects of the sulphated waters are observed in disordered conditions of the stomach, liver, and bowels, with the concomitant symptom of constipation. In sluggish states of the liver, characterized by a sallow countenance, yellowness of the conjunctivæ, coating of the tongue, and hemorrhoids, these waters are speedily beneficial. In eliminating the various chronic infections from the system—syphilitic, malarial, and strumous—as well as in expelling lead, mercury, and other metallic poisons, they furnish an important and useful adjunct to other remedial measures. The sulphated waters are likewise of considerable value in promoting the absorption of pleuritic and peritoneal transudations. On account of their accelerating influence on tissue-metamorphosis, they are prescribed with advantage in cases of corpulency and fatty infiltration. In organic cardiac diseases, accompanied by œdema of the lower extremities, with threatened general anasarca, these waters are

of great service in relieving the engorgement of the peripheral circulation and partially removing the strain on the heart. The value of a brisk saline will be generally acknowledged in the "rocky" state following alcoholic excesses. These waters are apt to act injuriously in chronic inflammatory or cancerous states involving the stomach, peritoneum, or intestines. They are likewise to be used cautiously in cases of extreme anæmia and in great debility. The sulphated waters are frequently impregnated with muriated saline ingredients, as well as with the alkaline carbonates and iron, under which circumstances their range of usefulness is materially broadened.

Sulphated Salines of the United States.—We present herewith the analysis of a very fair example of an American saline sulphated water, that of the Epsom, or Foley's, Spring, at the Crab Orchard Springs, Lincoln County, Kentucky. One United States gallon contains:

Solids.	Grains.
Magnesium sulphate	205.28
Sodium sulphate	59.07
Potassium sulphate	9.91
Calcium sulphate	10.79
Magnesium carbonate	7.64
Iron carbonate	traces
Calcium carbonate	53.18
Sodium chloride	17.72
Silica	3.26
Loss and moisture	34.58
Total solids	401.43
Carbonic acid gas	Not estimated.

Other American sulphated saline springs[1] are as follows:

North Carolina: Shocco Springs, Warren County, 68.06 grains of solid contents to the United States gallon.

Pennsylvania: Bedford Springs, Bedford County, the "Magnesia" Spring, 128.60 grs.

Tennessee: Crocker Springs, Davidson County, 94.08 grs.; Montvale Springs, Blount County (also chalybeate), 108.84 grs.; Tate Springs, Grainger County, 272.91 grs.

Texas: Gibson Mineral Well, Palo Pinto County, 329.65 grs.; Wootan Wells, Robertson County (also chalybeate), 213.57 grs.

Virginia: Blue Ridge Springs, Botetourt County, 157.37 grs.; Yellow Sulphur Springs, Montgomery County, 107.67 grs.

West Virginia: Salt Sulphur Springs, Monroe County, 172.48 grs.

Minnesota: Fort Crawford Mineral Well, Crawford County, 138.63 grs.

[1] Several American purgative springs were mentioned in the preceding paragraph.

Wyoming: Rawlins Springs, Carbon County, 76.09 grs.

The following additional springs may also be placed in this list:

Kansas: Manhattan Artesian Wells, Riley County, 117.88 grs.

Kentucky: Grayson Springs, Grayson County, 104.91 grs.

Mississippi: Cooper's Well, Hinds County, 95.48 grs.

Missouri: B. B. Mineral Spring, Pike County, 831.94 grs.

Georgia: Catoosa Springs, Catoosa County, 110.02 grs.

Illinois: American Carlsbad Springs, Washington County, 259.90 grs.

There are numerous other excellent sulphated saline springs in the United States, but want of space forbids their admission. It will be observed on comparison that the American purgative waters are, as a rule, not so densely impregnated with mineral ingredients as those of Europe. Nevertheless, many of them may be confidently relied upon as pleasant and efficacious cathartics or laxatives, and, clinically, will suffer by comparison with none in the world.

European Sulphated Saline Waters.—The following is an analysis of the celebrated Sprudel Spring of Carlsbad, Bohemia. One U. S. gallon contains:

Solids.	Grains.
Sodium sulphate	159.68
Potassium sulphate	2.96
Sodium chloride	69.79
Sodium carbonate	72.49
Magnesium carbonate	3.19
Calcium carbonate	16.02
Ferrous carbonate	0.25
Aluminium phosphate	1.72
Silica	8.42
Total solids	334.62
Carbonic acid	62.40 cubic inches.
Nitrogen	.24 " "

This well-known water, as will be observed, derives its purgative qualities almost entirely from the sulphate of sodium, the magnesic sulphate being absent. Other prominent European purgative springs are as follows: Carabaña Mineral Spring, Province of Madrid, Spain, 7391.23 grains of solid mineral contents per U. S. gallon; exceedingly strong in sodium sulphate, very little magnesium sulphate. Apenta Mineral Springs, near Buda-Pesth, Hungary, 2541.09 grs.; very rich in both sodium and magnesium sulphate. Springs of Rubinat (Serre), Province of Lerida, Spain, 5266.64 grs.; chiefly sodium sulphate, with a little magnesium sulphate. Friedrichs-Hall, Saxe-Meiningen, Germany, 1559.92 grs. Marienbad (Kreuz-Brunnen), Bohemia, 523.88 grs. Püllna, Bohemia, 2010.45 grs. Seidlitz, Bohemia, 897.59 grs.; this water gives its name, but not its mineral ingredients, to the familiar "Seidlitz" powders of the shops.

The Alkaline-saline Waters.

This important and valuable group of waters constitutes perhaps one-half of all the mineral springs of the United States, and also has numerous representatives among the European spas. The proportion of mineral ingredients varies greatly, however; thus, while some of these waters are among the richest known, others are so attenuated as to be scarcely distinguishable from ordinary potable water. In the author's work on mineral waters (*op. cit.*) he has placed in this classification all those waters in which the alkaline carbonates and the saline ingredients are conjoined in anything like equal terms, or where either of these groups of ingredients manifestly contribute materially to the medicinal value of the water. Some waters of this group contain with the alkaline carbonates the chlorinated salines, others the sulphated salines, while still others contain all three varieties of salts. The effects of these waters are brought about by the simultaneous introduction into the system of a double or a triple group of compounds somewhat differing in their individual influence, each of them supplementing to some extent the action of the others. They may be said, in the first place, to be antacid *par excellence*. The alkalies have been found to be indispensable to the process of endosmosis, combustion, digestion, and secretion. With the chloride of sodium they contribute to maintain the blood in the degree of viscosity necessary to keep it fitted for endosmosis and exosmosis. They aid in rendering the saccharine and amylaceous matters introduced by alimentation capable of combining with the oxygen and assisting in the functions of respiration and calorification. They are further believed to cause the elements of the bile to become fluid, preventing them from thickening or forming calculi, to promote intestinal digestion, to facilitate the secretions, and thus to influence all the acts of assimilation and nutrition. In a word, the waters containing these ingredients possess all the advantages which have been separately described under the alkaline and muriated saline groups. While many of the muriated alkaline-salines possess a certain laxative influence, those containing the sulphate of sodium or magnesium possess the advantage of more directly stimulating the emunctory action of the intestines, thus promoting the easy and painless removal of waste-products from the system. These waters thus become useful in the various chronic disorders of the alimentary tract characterized by the symptoms of catarrh of the stomach, intestinal sluggishness, hepatic torpor, and constipation. They may also be expected to render good service in cases of biliary and urinary calculi, in uric acid sand and gravel, in chronic bladder and urinary disorders, and in gout and rheumatism. Practical observations have

shown that they produce beneficial modifications in lymphatic and scrofulous constitutions, and in the various manifestations included under the generic term of the strumous diathesis. While perhaps not properly denominated curative, these waters undoubtedly in many cases favorably influence the course of chronic albuminuria and saccharine diabetes. Owing to their active influence on metabolism, the stronger waters of this class must be used with caution by cachectic, phthisical, or emaciated patients. Their use is contraindicated as a rule in acute inflammatory disorders and in chronic inflammations having a tendency to acute exacerbations. In persons suffering from atheroma, aneurysm, or very weak and debilitated conditions of the walls of the heart or great vessels they must be used guardedly.

American Alkaline-saline Springs.—We present herewith the analysis of the Hathorn Spring of Saratoga, New York, an excellent example of a muriated alkaline-saline water. One U. S. gallon contains:

Solids.	Grains.
Magnesium bicarbonate	176.46
Calcium bicarbonate	170.65
Sodium bicarbonate	4.29
Strontium bicarbonate	trace
Lithium bicarbonate	11.45
Iron bicarbonate	1.13
Barium bicarbonate	1.74
Sodium phosphate	trace
Sodium biborate	"
Sodium chloride	509.47
Potassium chloride	9.60
Sodium bromide	1.53
Calcium fluoride	trace
Sodium iodide	0.19
Alumina	0.13
Silica	1.26
Total solids	888.40
Carbonic acid gas	875.75 cubic inches.

All of the Saratoga waters partake more or less of the characteristics of the Hathorn Spring. It has been well said that collectively they constitute the finest group of alkaline-saline springs on the globe. Other excellent American springs of this character are as follows (those containing purgative principles, sulphate of magnesium or potassium, are so designated):

California: Aguas Calientes, San Diego County, 39.30 grains per U. S. gallon; Allen Springs, Lake County, 142.86 grs.; Azule Springs, Santa Clara County, 261.68 grs.; Castalian Mineral Springs, Inyo County (sulphated), 4422.25 grs.; El Paso de Robles Springs, San Luis Obispo County, 101.47 grs.; Gordon Springs, Lake County,

90.80 grs.; Highland Springs, Lake County, 156.86 grs.; Litton Seltzer Springs, Sonoma County (sulphated), 223.46 grs.; Owen's Lake, Inyo County (sulphated), 5835.62 grs.

Colorado: Manitou Soda Springs, El Paso County, the "Navajo," 182.23 grs.

Georgia: Bowden Lithia Springs, Campbell County (sulphated), "Upper" Spring, 200.94 grs.

Idaho: Idanha Spring, Bannock County (sulphated), 152.06 grs.

Indiana: Indian Springs, Morton County (sulphated), 163.67 grs.; West Baden Springs, Orange County (sulphated), 301.87 grs.

Iowa: Foy's Mineral Spring, Jasper County (sulphated), 153.71 grs.

Kansas: Topeka Mineral Wells, Shannon County (sulphated), 147.35 grs.; Waconda Spring, Mitchell County (sulphated), 1120.65 grs.

Michigan: Americanus Mineral Well, Ingham County, 503.90 grs.

New York: Ballston Spa, Saratoga County, Artesian Lithia Spring, 1233.25 grs.

Oregon: Wilhoit's Soda Springs, Clackamas County, 421.97 grs.

South Carolina: Old Artesian Well, Charleston, 135.37 grs.

Tennessee: Dixie Springs, Knox County (sulphated), 313.74 grs.

Washington: Medical Lake, Spokane County, 101.45 grs.

West Virginia: Borland Mineral Well, Pleasants County, 432.28 grs.

There are numerous other springs coming under this classification in the United States, most of them somewhat feebler, but lack of space forbids their introduction.

European Alkaline-saline Springs.—Analysis of the Apollinaris Springs, Neuenahr, Rhenish Prussia. One U. S. gallon contains:

Solids.	Grains.
Sodium chloride	28.56
Sodium sulphate	18.40
Sodium carbonate	77.20
Magnesium carbonate	27.12
Calcium carbonate	3.60
Ferric oxide	1.20
Alumina	1.20
Silica	.48
Total solids	157.76
Free carbonic acid gas	376.32 cubic inches.

This water is exported in large quantities to the United States.

The following are also well-known European alkaline-saline springs: Bilin, Bohemia (Joseph-Quelle), 304.49 grains per U. S. gallon; Bour-

bonne, Haute-Marne, France, 483.47 grs.; Alkaline-saline Springs at Carlsbad, Bohemia, 55.17 grs.; Contrexville (Pavillon), Vosges, France, 171.75 grs.; Ems on the Lahn (Kessel-Brunnen), 169.75 grs.; Luhatschowitz, Moravia, 438.04 grs.; Obersalz-Brunn, Silesia, 138.08 grs.; Selters, Nassau, Germany, 228.14 grs.; Vals, France (Desirée Spring), 535.88 grs.; Weilbach, Hesse, Germany, 165.27 grs.

Chalybeate Waters.

Chalybeate waters owe their virtues to the presence of iron in greater or less quantities. This element is, perhaps, most often found in springs in the form of the bicarbonate, although many analyses show the sulphate, some the oxide, and still others the chloride. The bicarbonated chalybeate waters are usually most valuable for internal administration. Not only does carbonic acid increase the solubility of the iron, but it disguises its otherwise astringent and ferruginous taste, and aids its speedy absorption and assimilation. These waters prove of great value in cases of anæmia or poverty of the blood. Clinical experience shows that they cause an increase in the appetite, a return of normal color, a gain in weight and strength, and a general improvement in the bodily functions. Investigations with the hæmoglobinometer have further proved that the deficiency of the coloring-matter of the blood observed in anæmic states may be speedily made up by the administration of a properly selected chalybeate water; and as iron in many of its pharmaceutical forms frequently disagrees with the stomach, we have in natural mineral waters a pleasant and safe means of introducing it into the system. It is not essential that the iron be present in large quantities. A chalybeate water containing not more than one grain of iron to the gallon will speedily show its influence in the returning color of the face and increased tone and vigor of the system. The indications for the use of iron waters are numerous. It may be said that they serve a useful purpose in almost all debilitated states of the system accompanied by a loss in the hæmoglobin of the blood. In slow convalescence from acute diseases, in the anæmic state resulting from a severe operation or difficult confinement, in all forms of hemorrhage not due to fulness of the vessels or fragility of their coats, in amenorrhœa when due to chlorosis, in the debilitating catarrhs of the uterus and vaginal mucous membrane, and in the various cachexias, the chalybeate waters may be confidently expected to render valuable aid. Iron waters should be taken guardedly by stout, red-faced, plethoric persons. They are directly contraindicated in cases of vertigo or rush of blood to the head, and in all cases where there is reason to suspect the integrity of the bloodvessels.

The sulphate of iron is found in large quantities in a number of

springs. All of the acid and most of the sulphur springs are rich in this salt. The sulphate of iron waters have excellent properties as astringents and tonics, but they are not so palatable nor so well adapted to general use as the carbonated chalybeates.

American Chalybeate Springs.—The United States is fortunate in the possession of a large number of valuable springs of the chalybeate class. The limits of this article admit of the mention of only a few of the most prominent or more strongly mineralized. The following analysis shows the composition of the Pacific Congress Springs (strong chalybeate), of Santa Clara County, California. One U. S. gallon contains:

Solids.	Grains.
Ferrous carbonate	13.87
Potassium carbonate	2.06
Sodium carbonate	120.42
Magnesium carbonate	26.34
Calcium carbonate	16.03
Sodium sulphate	12.95
Magnesium sulphate	14.17
Calcium sulphate	14.19
Sodium chloride	115.76
Alumina	4.50
Silica	3.98
Organic matter	trace
Total solids	334.27
Free carbonic acid gas	41.17 cubic inches.

Other American iron springs are as follows (the first figures show the quantity of iron per United States gallon; the second, the total quantity of solid ingredients per United States gallon expressed in grains):

Alabama: Matchless Mineral Wells, Butler County, 167.91—545.60 (one of the most potent chalybeates known).

Arkansas: Arkansas Lithia Springs, 12.34—73.21.

California: Fulton Wells, Los Angeles County, 11.75—81.13; one of the California Geyser Springs, Sonoma County, 28.81—221.26; Glen Alpine Springs, El Dorado County, 1.80—118.80; Excelsior Spring, Howard Springs, Lake County, 1.85—156.84; Little Seltzer Springs, Sonoma County, 2.14—223.46; Pagoda Spring, Napa County, 7.90—67.15.

Colorado: Springdale Seltzer Springs, Boulder County, 3.99—171.27.

Georgia: Puller Springs, Cobb County, 3.50 (total quantity solids not estimated).

Indiana: Indian Springs, Martin County, 20.23—163.67.

Iowa: White Sulphur Springs, Scott County, 27.37—307.04.

Kansas: Arrington Mineral Springs, Atchison County, 3.57—43.58; Topeka Mineral Wells, Shawnee County, 28.06—147.35.

Maine: Addison Mineral Springs, Washington County, 1.65—8.14.

Maryland: Mardella Springs, Wicomico County, 11.50—15.30.

Michigan: Fruit-Port Well, Muskegon County, 7.50—703.13.

Mississippi: Spring No. 1, Brown's Wells, Copiah County, 36.52—263.23; Cooper's Well, Hinds County, 3.36—9548.

Missouri: Round Spring, Aurora Springs, Miller County, 6.06—20.87.

New Hampshire: Londonderry Lithia Spring, Rockingham County, 1.85—74.85.

New Jersey: Heath House Spring, Schooley's Mountain Springs, Morris County, 4.00—91.00.

New York: Adirondack Mineral Spring, Washington County, 5.04—76.89; Spring No. 1, Oak Orchard Acid Springs, Genesee County, 28.62—314.42; Putnam Spring, Saratoga Springs, Saratoga County, 7.00—361.01 (all of the Saratoga springs contain more or less bicarbonate of iron).

Pennsylvania: Gaylord and Gulick Mineral Springs, Tioga County, 31.63—85.18.

Tennessee: Austin Springs, Washington County, 17.60—46.00.

Texas: Well No. 2, Overall Mineral Wells, Robertson County, 144.90–234.98.

Virginia: Bath Alum Spring, Bath County, Spring No. 2, 26.78—65.38; Rock Emon Springs, Frederick County, 14.25—240.43.

European Chalybeate Springs.—We present in the following table a list of the mineral contents of the Chalybeate Springs at Brighton, England. One U. S. gallon contains:

Solids.	Grains.
Ferrous sulphate	14.40
Calcium sulphate	32.72
Sodium chloride	12.24
Magnesium chloride	6.00
Silica	1.12
Loss	1.52
Total solids	68.00
Carbonic acid gas	20.00 cubic inches.

Other well-known European chalybeates: Pyrmont Waldeck, Germany (Trink-Brunnen), 2.48 grains of iron per U. S. gallon—178.20 grains of total mineral contents per U. S. gallon; Schwalbach, Nassau, Germany (Stahl-Brunnen), 3.74—25.72; Spa (Pouhon), Liege, Belgium, 5.42—20.86; St. Moritz (Grande Source), Grisons, Switzerland, 1.38—82.78; Tunbridge Wells, England, 2.22—761.

Other well-known European springs also contain iron, but this substance is overshadowed by other ingredients.

On Thermal and Sulphureted Waters, and the Use of Baths at Mineral Springs.

As thermal and sulphureted waters have much in common, it has been deemed proper to consider them collectively. A majority of warm or hot natural waters are also charged with hydrogen sulphate, and both groups are much more largely used for bathing or external purposes than for internal use. Many thermal waters, however, are also impregnated with valuable solid mineral ingredients, and some are highly prized for the same class of cases to which cold waters of the same variety are applicable. A thermal spring is one whose temperature is higher than the average annual temperature of the circumambient atmosphere. Thus a mineral water may be thermal in one portion of the country while in other warmer parts it would not be properly so classified. For practical purposes it is customary to term all springs above 70° F. as thermal, and those below as cold. Thermal springs having a temperature between 70° F. and 98° F. are designated as warm; those above 98° F. as hot.

Hydrogen sulphide gives character to the sulphureted class of waters, and is an important component of many of our most valuable thermal springs as well as of a large number of cold springs. It occurs most frequently in a free state, but is sometimes found in combination as sulphides with sodium, calcium, potassium, or magnesium. This substance imparts to its waters their peculiar odor of decayed eggs, which at some springs is appreciable at a considerable distance with a favorable wind. The hot sulphureted springs are most frequently observed in mountainous or volcanic regions, and contain sulphates of a number of the elements and occasionally sulphides and sulphuric acid. Many of them are also strongly impregnated with chloride of sodium. The activity of sulphureted hydrogen when taken into the stomach is open to doubt. Dr. Moorman,[1] who observed the effects of the sulphureted waters for many years at the Greenbrier White Sulphur Springs of West Virginia, looked upon it as possessing an alterative action equal to that of mercury in syphilitic diseases. It cannot be disputed that these waters promote activity of the bowels and kidneys. They are highly advocated by medical practitioners of experience in gout, rheumatism, chronic synovitis, white swelling, and many skin diseases. Some of the sulphur springs have long been celebrated in the treatment of chronic malarial infection accompanied by an enlarged spleen and liver, and in hepatic congestion, abdominal

[1] *Mineral Springs of North America*, 1871.

plethora, and hemorrhoids. They have also been found useful in certain female pelvic disorders, especially in chronic uterine inflammations. It is probable that the older writers overestimated the cholagogue influence of this substance. We may readily believe that many of our well-known sulphur springs owe their celebrity more to coexisting ingredients than to the sulphureted hydrogen which they contain.

The various hydriatric uses of water by means of baths, douches, sprays, affusion, etc., are considered in the section devoted to Hydrotherapeutics (see p. 361). It remains for us here to refer briefly to the use of baths at mineral spring resorts. Important questions are as follows: Does the heat of waters received from natural sources (*i. e.*, the internal heat of the earth or from chemical or volcanic action) impart to them any advantages over that produced by warming them artificially, or do the various solid and gaseous ingredients with which mineral waters are charged influence the action of these waters when applied to the skin? To the first question we may venture an unqualified negative. No evidence has ever been adduced to show that the high temperature of thermal spring waters itself conveys to them any useful effects which cannot also be derived from the artificial heating; although it is not to be doubted that the heat aids in the solvent power of the water over some of the chemical substances which it meets in its subterranean journeyings, and thus contributes to its mineral richness. Nor are we prepared to attach the same faith to the absorptive power of the skin which was once credited to that important organ. The cutaneous investment of the body undoubtedly takes up gases to a certain extent, and it is possible that a strong salt solution may be partially absorbed at a favorable temperature—92°–97° F. It is only proper to say, however, that under the ordinary circumstances of the bath the weight of modern testimony opposes the view that there is any appreciable interchange of fluids between the blood and the bath-medium. It is well known that certain substances, notably mercurials and cod-liver oil, may, by vigorous friction or inunction over the surface when the skin is thin, be made to pass into the patient's circulation to a limited degree, but this cannot apply to the bath. The constant presence of oil globules in the pores of the skin prevents the taking up of water, and it passes off as if "from a duck's back." In the case of medicated or mineral baths, therefore, any modification of the effects of the simple bath may be attributed in a great degree, if not altogether, to the local influence of the artificial or natural ingredients of the water upon the cutaneous covering of the body. But we cannot overlook the fact that many forms of chronic complaints are treated successfully by a systematic course of bathing at a spa after having

resisted all other methods of treatment. We may properly attribute this fortunate outcome to the stricter regime observed at the springs, to the greater willingness of the patient to adhere to strict instructions than at home, and to the favorable circumstances of environment, climate, scenery, absence of home cares, etc. Sulphureted hydrogen waters are widely used for bathing at springs, and are recommended for many diverse conditions, notably tertiary syphilis, chronic rheumatism and rheumatoid arthritis, stiff joints, old glandular swellings, the scaly skin diseases, chronic malarial toxæmia, metallic poisoning, portal congestion, etc. It is impossible, however, to trace in a scientifically satisfactory manner the undoubted valuable influence of sulphureted waters to the gas itself, to which so much importance has been attached by spring managers as well as by many physicians. In some instances no doubt the conjoined internal and external use of the waters is responsible for the good results, while in all cases we must attach a certain influence to good discipline, pleasing scenery, salubrious climate, cheerful environment, etc., and possibly in some cases to the influence of suggestion found in the fact of the natural heat, powerful odor, and peculiar appearance of thermal sulphureted waters. At any rate, medical practitioners who have seen the valuable effects of these baths will not cease to recommend certain of their patients to them while awaiting an exact scientific explanation as to their mode of action.

American Bathing Springs.—We present below analyses of two well-known American bathing springs of the sulphureted variety, viz., the White Sulphur Spring at Richfield Springs, New York, a cold sulphureted water, and the Yampa Spring at Glenwood Springs, Colorado, of the thermal sulphureted type.

1. The "White Sulphur," Richfield Springs, New York. One U. S. gallon contains:

Solids.	Grains.
Sodium hydrosulphate	1.72
Calcium hydrosulphate	0.09
Potassium sulphate	1.67
Calcium sulphate	112.34
Strontium sulphate	0.01
Barium sulphate	trace
Magnesium sulphate	5.15
Sodium hyposulphite	0.38
Magnesium bicarbonate	31.74
Iron bicarbonate	trace
Calcium phosphate	"
Sodium chloride	0.52
Lithium chloride	0.02
Alumina	trace
Silica	0.64
Total	154.28
Sulphureted hydrogen gas	14.20 cubic inches.

2. The "Yampa," Glenwood Springs, Colorado. One U. S. gallon contains:

Solids.	Grains.
Sodium chloride	1089.83
Magnesium chloride	13.09
Sodium bromide	0.56
Sodium iodide	trace
Calcium fluoride	"
Potassium sulphate	24.04
Calcium sulphate	92.38
Lithium bicarbonate	0.22
Magnesium bicarbonate	13.55
Calcium bicarbonate	24.37
Iron bicarbonate	trace
Sodium phosphate	"
Sodium biborate	"
Aluminum	"
Silica	1.97
Organic matter	trace
Total solids	1260.01

Sulphureted hydrogen and carbonic acid gases copiously discharged from spring, but quantity not estimated. Temperature of water as taken by the writer at the spring, 124.6° F.

The United States possess a very large number of both hot and cold sulphureted springs, as well as numerous thermal springs which are not sulphureted. Some of the bathing-resorts contain many adjuncts of *fin de siecle* civilization, and are not surpassed by the most progressive spas of Europe in facilities for the creature-comforts and well-being of their patrons. Following are the names and locations of a number of the better-known springs. The total solid contents are expressed in grains per U. S. gallon. In the case of thermal springs the temperature is given in degrees F.

Alabama: Blount Springs, Blount County, Spring No. 4, 55.55.

Arkansas: Hot Springs, Garland County, 8.55; temp., lowest 76°, highest 157° F.

California: Anderson Springs, Lake County, "Cold Sulphur" Spring, 77.63. Arrowhead Hot Springs, San Bernardino County, 63.39; temp., 193° F. Calistoga Springs, Napa County, Swimming Pool, 41.98; temp., 121.6° F. El Paso de Robles Hot and Cold Sulphur Springs, San Luis Obispo County, "Main Sulphur" Spring, 101.47; temp., 105° to 110° F. California Geysers, Sonoma County, 7.12 to 296.24; temp., 150° to 214° F. Gilroy Hot Springs, 62.86; temp., 108° to 115° F. Harbin Hot Sulphur Springs, Lake County, 87.43; temp., 122° F. Paraiso Hot Springs, Monterey County, the "Great Paraiso" Spring, 61.04; temp., 118° F. Santa Barbara Hot Springs, 36.69; temp., 99° to 122° F. Skagg's Hot Springs, Sonoma County, 216.35; temp., 120° to 140° F.

Colorado: Hot Sulphur Springs, Middle Park, Grand County, Red Sulphur Spring, 101.75; temp., 109.5° F. Pagosa Springs, Archuleta County, 351.09; temp., 155° F. Poncho Hot Springs, Chaffee County, 101.00; temp., 145° to 185° F. Royal Gorge Hot Springs, Fremont County, 217.00; temp., 102° F.

Florida: Suwanee Sulphur Springs, Suwanee County, 21.61.

Georgia: Warm Springs, Meriwether County, 10.70; temp., 90° F.

Iowa: White Sulphur Springs, Scott County, 307.04.

Michigan: Alpena Magnetic Sulphur Spring, 534.39. Moorman Mineral Well, Washtenaw County, 2256.26.

Missouri: Montesano Springs, Jefferson County, 541.62.

Montana: Ferris Hot Springs, Gallatin County, 34.34. Hunter's Hot Springs, Gallatin County, 16.85; temp., 148° to 168° F.

Nevada: Walley's Hot Springs, Douglas County, 25.41; temp., 136° to 160° F.

New Mexico: Hudson Hot Springs, Grant County, 24.94; temp., 142° F. Las Vegas Hot Springs, San Miguel County, 31.65; temp., 110° to 140° F. Ojo Caliente (Hot Springs), Taos County, 135.54; temp., 90° to 122° F.

New York: Avon Springs, Livingston County, 205.61. Cherry Valley Springs, Otsego County, 184.88. Chittenango Sulphur Springs, Madison County, 153.35. Clifton Springs, Ontario County, "Sulphur" Spring, 133.68. Columbia Springs, Columbia County, 218.60. Doxtatter's Mineral Well, Monroe County, 119.92. Lebanon Springs, Columbia County, 24.38; temp., 75° F. Massena Springs (or St. Regis Springs), St. Lawrence County, 191.88. Sharon Springs, Schoharie County, 149.10.

North Carolina: Hot Springs, Madison County, 42.86; temp., 96° to 104° F.

Ohio: Cincinnati Artesian Well, 617.32.

Oregon: Belknap Hot Medical Springs, Lane County, 145.51. Des Chutes Hot Springs, Crook County, 77.61.

Pennsylvania: White Sulphur Springs, Bedford County, 13.74.

South Dakota: South Dakota Hot Springs, Fall River County, "Minnekahta" Spring, 62.51; temp., 62.51° F.

Tennessee: Crocker Springs, Davidson County, 94.08. Fernvale Springs, Williamson County, 73.84. Red Boiling Springs, Macon County, "Red" Spring, 47.82. Upper Red Boiling Springs, Macon County, 91.39.

Texas: Terrell Hot Medicinal Well, San Antonio, solid contents (about), 260 grs. per United States gallon; temp., 105.5° to 109° F.

Utah: Beck's Hot Sulphur Springs, Salt Lake County, 848.85; temp., 128° F. Midway Warm Springs, Wahsatch County, 102.74; temp., 85° to 112° F. Utah Hot Springs, 1354.55; temp., 131°

to 144° F. Warm Springs, Salt Lake County, 353.73; temp., 112° F.

Vermont: Alburgh Springs, Grand Isle County, 38.00.

Virginia: Alleghany Springs, Montgomery County, 183.06. Blue Ridge Springs, Botetourt County, 157.37. Cold Sulphur Springs, Rockbridge County, 13.67. Fauquier White Sulphur Springs, Fauquier County, 22.00. Hot Springs, Bath County, "Boiler" (Bath) Spring, 43.33; temp., 108° F. Healing Springs, Bath County, "Old" Spring, 35.86; temp., 85° to 88° F. Warm Springs, Bath County, 32.63; temp., 96° F. Roanoke Red Sulphur Springs, Roanoke County, 27.66.

West Virginia: Addison Sulphur Springs, Webster County, 467.30. Greenbrier White Sulphur Springs, Greenbrier County, 129.66. Red Sulphur Springs, Monroe County, 23.96. Salt Sulphur Springs, Monroe County, 172.48.

Wyoming: Rawlin's Springs, Carbon County.

It will be observed that the names of several American springs appear in two or more of the lists mentioned. This is for the reason that they are sufficiently impregnated with mineral ingredients to entitle them to a place in two or more separate classifications.

European Bathing and Thermal Springs.—The names of several European thermal springs have been mentioned in the foregoing lists. Following are the names and mineral strength of other well-known resorts of this variety:

Aix-le-Bains, Savoy, France, total solid contents, 25.07 grains per U. S. gallon; temp., 108° to 110° F. Aix-la-Chapelle, Rhenish Prussia (Kaiser-Quelle), 244.81; temp., 131° F. Baden-Baden, Baden, Germany, Haupt-Quelle, 174.35; temp., 155° F. Bagnères-de-Bigorre (La Reine), Hautes-Pyrénées, France, 160.89; temp., 115.7° F. Bagnères-de-Luchon (La Reins), Authe-Garonne, France, 13.79; temp., 131° F. Bath, England (King's Well), 144.34; temp., 115° F. Bourbonne, Haute-Marne, France, 483.47; temp., 149° F. Carlsbad, Bohemia, 251.68 to 334.66; temp., 122° to 165° F. Ems on the Lahn, Germany, 169.75; temp., 115° F. Gastein Salzburg, Austria, 21.20; temp., 87° to 160° F. Leuk, Valais, Switzerland (Lorenz-Quelle), 126.64; temp., 123° F. Springs of Nauheim, Hesse-Cassel, Germany (Friedrich Wilhelm's Quelle), 2148.07; temp., 98.5° F. Schangerbad, Nassau, Germany, 20.46; temp., 82.4° to 89.6° F. Töplitz, Bohemia (Haupt-Quelle), 38.42; temp., 120° F. Wildbad, Wurtemberg, 36.64; temp., 94° F. Wiesbaden, Nassau, Germany (Koch-Brunnen), 507.70; temp., 155.75° F.

Other Forms of Bathing at Spas.—*The Carbonic Acid Bath.*—As we have seen, carbonic anhydride, or carbonic acid gas, is an important and abundant ingredient of many mineral waters. It is

present to more or less extent in all sulphureted waters. The internal uses of this compound and its relations to other chemical constituents of mineral waters have already been considered. The physiological action on the skin of a strongly carbonated water is readily appreciated by the bather. The gas produces a lively sensation of warmth, with redness and formication, attended by a diminished pulse-rate and coldness of the feet. The bath is followed by a sense of vigor and activity. The customary carbonic-acid bath is prepared by collecting the gas in an impervious box, in which the bather remains seated while the head is in the outer air, precautions being taken that not enough of the gas escapes from the box to injure the patient. These baths have been found useful in recent paralysis, neuralgia, and rheumatism. They are also recommended by Frerichs in sexual neurasthenia, in various nervous disturbances characterized by local anæsthesia and hyperæsthesia, and in reflex and hysterical paralyses. Locally, the gas is used in throat and other troubles by means of apparatus devised for the purpose. Carbonic acid gas and the chlorides of sodium and calcium form the essential components of the springs of Nauheim, at which the Messrs. Schott Brothers have inaugurated their now celebrated method of treating chronic heart diseases. The results show that these baths, supplemented by the system of exercise or light gymnastics employed at Nauheim, tend to regulate the action and improve and strengthen the nutrition of the diseased heart, whether depending upon valvular lesions or upon malnutrition or disease of the muscular structure of the organ. Numerous carbonated brine springs in the United States possess the requisite chemical constituents of these baths, and at several American resorts they are in successful use.

Independently of carbonic acid, *brine baths* act as a powerful stimulant to the cutaneous nerves, promoting the peripheral circulation and, perhaps by reflex action, influencing remote organs and even the nerve-centres. Elimination by the kidneys and skin is undoubtedly stimulated. When judiciously employed they prove useful in paralysis of several varieties, in scrofulosis, and in chronic rheumatism. Brine vapor-baths stimulate the mucous membranes of the broncho-pulmonary tract and promote expectoration.

The Mud or Moor Bath.—Mud-bathing, or terra-therapy, is of ancient origin. There are evidences which show that it was in common use among the American aborigines. At several spring resorts the earth surrounding the fountains becomes more or less saturated with the mineral ingredients of the escaping water. It may be of sufficient heat and of proper consistency to apply directly to the skin, but at most resorts it is placed in a large vat and mixed with the

mineral water, either naturally or artificially heated, until it becomes plastic. The patient then immerses himself in the hot mineral mud, or reclines on a table and is plastered with it by an attendant. The bath may vary in duration from a few minutes to several hours. The mud, being a slow conductor of heat, may be used at a higher temperature than the water. It is said that a heat of 120° F. is well borne. The patient now enters a warm-water bath, where he is thoroughly cleansed, rubbed, and dried, and in some cases treated to a cold shower-bath or other cold affusion. It was once supposed that the mud applied in this way absorbed toxic and detrimental material, such as uric acid, metallic poisons, etc., through the skin. This theory, however, has been abandoned. Nor indeed is it probable that the mineral constitution of the mud materially influences its action, which is essentially that of a universal hot poultice. Its chief effects are shown by a lively excitation of the skin followed by free perspiration. In localities where mud baths are in vogue it is claimed that they are of great benefit in chronic rheumatism, stiff joints, glandular swellings, and in chronic diseases of the skin. They are also recommended in chronic hypertrophic states of the liver and spleen, in renal diseases, and in old inflammations involving the uterus, ovaries, and bladder. The mud bath is sometimes used locally in the form of a knee-bath, a foot-bath, or an arm-bath.

The Peat Bath.—This bath is still in high favor at several of the European spas, notably at Franzensbad and at Carlsbad. Peat consists of a dense mass of disintegrated stalks and roots, the product of the decomposition undergone by vegetable growths flourishing in shallow, standing mineral water in the absence of atmospheric oxygen, and at a moderate and equable temperature. Every autumn the peat is dug up by specially constructed machines and thrown upon the slope of a hill, where it lies for months undergoing a process of oxidation. The dry, or weathered, peat is ground in mills constructed for the purpose, and the baths are prepared by mixing it with hot mineral water and stirring it vigorously. The bather enters the bath-tub when the water is of the proper temperature, and is thoroughly laved with the liquid, remaining in the bath from a few minutes to an hour or more according to the physician's orders. A peat, as well as a mud, bath should invariably be followed by a bath of the mineral water, using soap, bran, or other substance to secure perfect cleanliness. According to Prof. Frerichs, the peat bath has valuable tonic as well as sedative properties, and is of great benefit in glandlar enlargements, excessive contractions, presumably from burns, gun shot wounds, operation wounds, strumous ulcerations, chronic rheumatism, sciatica, and other affections. At Franzensbad it is used extensively in the treatment of female pelvic disorders, a large pro-

portion of the cases treated being of this class. Like the mud bath, the peat bath is often used in the form of the half-bath, the hip-bath, the foot-bath, and in the form of fomentations to local painful conditions.

Precautions as to Hot Bathing.—There are certain precautions regarding the use of the hot mineral peat or mud bath which, indeed, it is well to observe in taking hot baths of any kind. For a short time prior to the bath it is important to avoid carefully all excitement or fatigue, or anything that is liable to accelerate the circulation of the blood or produce palpitation of the heart or hyperæmia of the brain. A hot bath should never be taken on a full stomach, an interval of at least three hours being allowed to elapse after a meal. The variety of the baths, their frequency, and their duration must in every case be determined by the physician, who is to be guided by the nature of the disease, the age and constitution of the patient, etc. After taking a number of mineral hot baths it is quite common to get an eruption on the skin, sometimes causing considerable itching, called the "bad friesel," or "bath rash." It usually subsides within two or three days after suspension of the baths. In warm weather patients may take a short walk after the bath, but in cold, damp weather they should at once repair to a warm room and rest for a short time. Some patients have a tendency to giddiness or fulness in the head during a hot bath. Such persons should keep a cold, wet towel or ice-bag to the head while in the bath.

Neutral or Indifferent Waters.—A considerable number of natural waters are found in the market the proportion of mineral ingredients in which are so small that it has been thought best to place them in a separate classification under the head of Neutral or Indifferent Waters. Several well-known commercial springs are found in this list, among them being the Poland Springs of Maine, with 3.76 grains of solid contents per U. S. gallon; the Highland Springs of the same State, 4.78; the Commonwealth Mineral Spring, 2.45; the Massasoit Spring, 3.43; and the Nobscot Mountain Spring, 3.21, all of Massachusetts; the Birddah Springs of New Hampshire, 5.92; and the Colonial Springs of Long Island, New York, 2.50. A majority of the New England springs would fall into this class. These waters form a pure, safe, and wholesome beverage, as a rule, and are well adapted for the table. At several of the springs of this type, notably at the Poland Springs in Maine, elegant and commodious summer-resorts have come into existence.

DISEASED CONDITIONS IN WHICH MINERAL WATERS ARE FOUND USEFUL.

In some of the foregoing sections of this article brief reference has been made to the therapeutics of mineral waters. As this is beyond doubt the most important feature of the subject, it would seem advisable to give it some consideration from the standpoint of the morbid states or diseases in which these agents have been shown to be of value.

Imperfect or Impeded Convalescence.—Although mineral waters are, as a rule, inapplicable to the acute manifestations of disease, they may serve as useful adjuvants in tardy or delayed convalescence from such affections. Let us suppose that a patient has suffered in the winter or spring from a severe attack of la grippe, pneumonia, or bronchitis. The chief symptoms have duly subsided, but a good deal of bronchial irritation remains, with perhaps a teasing, irritating cough, especially in the evening. The appetite is not very good, the face is pale, and it is plainly evident that the individual is not up to the normal standard of health. As the summer season comes on a change of climate is indicated. Such a person may properly be recommended to a high, or moderately high, mountain resort, and if his physician is sufficiently familiar with mineral spring resorts to refer him to a locality where a fairly strong chalybeate water may be had, he will be placed under perhaps the best possible conditions and environments for a speedy restoration to health. Take, again, a person who has suffered a sharp attack of articular rheumatism. The pyrexia has disappeared, the joint-symptoms have measurably subsided, and the patient is able to be up and walk about: yet he is in a nervous, irritable state; the heart's action is excitant, albeit there may be no valvular trouble; occasional sharp pains, or else a dull aching sensation, may be experienced in the joints or in the adjacent muscular structures. This continues for some time in spite of salicylates and alkalies. The stomach is becoming intolerant, and the patient is showing signs of anæmia. A change of surroundings is often desirable in such cases, and if the circumstances are favorable we cannot do better than refer the patient to a locality where, in addition to pure air and pleasant scenery, he may have the benefit of a suitable water. Such patients stand travel badly, and should not be sent far from home, nor to an elevation of more than 1500 above the sea-level. A water containing alkaline and saline elements, with perhaps a small proportion of iron, is best suited for this class of cases. In the debility resulting from almost any acute prostrating disease—malaria or typhoid fever, or the exanthemata—a severe or protracted parturition, a bloody surgical operation, or a gunshot or

other wound, a few weeks' sojourn at a spa where light carbonate or ferruginous waters may be drunk freely as they flow from the fountain will do much to assist the natural processes in restoring strength and vigor.

General Debility.—This is one of the camp-followers of civilization. It is not a disease, yet it is a symptom of almost all chronic constitutional disorders. Moreover, it frequently exists *per se*, or without any concomitant disease as far as we can determine. The modern term neurasthenia is no doubt frequently applied to this condition. It may be the result of overwork, anxiety, grief, dissipation, etc., and makes its presence felt in protean ways. It is the common complaint of hot weather, and probably few human beings in our cities escape at least a touch of debility during the summer months. Perhaps the most common marks of its presence are as follows: disinclination to rise in the morning, indisposition to exertion, loss of interest in the affairs of life, lassitude, stretching, yawning, etc. The stomach is easily upset, the individual is quickly exhausted on exertion, there may be a dull ache in the lumbar region, weak knees and muscular tremors, and a played-out feeling generally. A light alkaline chalybeate water will be found very useful in this condition, and if it can be imbibed at its fountain, amid bright and attractive scenery, salubrious air, and cheerful surroundings, a speedy recovery may be confidently expected. A morning sponge or shower-bath of the water, if well tolerated, followed by a vigorous rub and a short walk or other light exercise in the open air, will be found a valuable adjunct to the treatment.

Anæmia and Chlorosis.—No fact in the whole field of clinical medicine has been more clearly demonstrated than that of the value of the ferruginous preparations in anæmic states. But medical men are at variance regarding the most eligible method of introducing iron into the system. It is well known that many of the pharmaceutical preparations are not only objectionable to the palate, but are quickly followed by symptoms of gastric or intestinal disorder. The accumulated evidence of many generations of medical men has shown that anæmia often yields more readily to an easily assimilable chalybeate water than to any of the known artificial preparations of iron. This is especially true of long-standing or neglected cases. The arsenical waters are also valuable in conditions characterized by poverty of the blood. Disorders of the female pelvic organs marked by the presence of amenorrhœa, dysmenorrhœa, and associated symptoms are also benefited or cured by these agents.

Gastric, Intestinal, and Hepatic Disorders.—The waters *par excellence* for ordinary gastric dyspepsia presenting the symptoms of acid eructations, pyrosis, fulness after meals, etc., are those plentifully

impregnated with carbonic acid and the alkaline carbonates. The carbonates of sodium and magnesium are especially valuable. If there be a tendency to diarrhœa, the carbonate of lime is of much utility. In atonic dyspepsia characterized by peristaltic inertia and deficient secretion of gastric juice waters rich in chloride of sodium and carbonic acid are needful. These may be taken before meals, and cold, so as to retard stomach absorption and emphasize the local stimulating effect. It should be borne in mind that no form of internal medication, either by mineral waters or by drugs, will prove permanently useful without a proper regulation of the diet; and it is the province of the physician to give specific instructions on this important point in each case.

Constipation.—This disagreeable condition may exist with or without gastric dyspepsia, and is seldom a primary affection, being usually dependent upon a variety of other derangements. The determining factors are usually a deficiency of the normal intestinal secretion or a loss of peristaltic power of the intestinal muscular coats. In many obstinate cases of this kind a course of mineral waters is a valuable adjunct to the treatment, and with proper dietary rules will usually prove successful. One of the sulphated saline or bitter waters is applicable to these cases. The presence of a certain amount of chloride of sodium and the alkaline carbonates held in solution by carbonic acid gas lends additional efficacy to the water. We have fortunately many such waters in the United States, and the springs from which they flow are within easy reach of almost all sections of the country. Many of the bicarbonated magnesic waters, notably those of Saratoga, render exceedingly useful service in these conditions.

Diarrhœa and Dysentery.—In some parts of the United States, particularly in Virginia and California, medical practitioners have long been in the habit of prescribing alum-waters for obstinate cases of summer diarrhœa and for dysentery of long standing. Some of the ferruginous and acid waters have also found favor in these affections. It is probable, however, that the stronger calcic waters are more generally useful than others in conditions marked by looseness of the bowels. A sojourn at one of the calcic spring resorts has often proved successful in refractory cases when other medication had failed.

Abdominal Venosity, or the Full Habit.—This condition is also variously described under the names of abdominal plethora, the hemorrhoidal diathesis, portal obstruction, abdominal stasis, etc., and is usually dependent upon an engorged liver. We find frequent examples of this condition among the luxurious club *habitués* of our large cities. It is the bane of rich men's sons and of the business man successful in early life, who no longer has the incentive to bestir himself. It is a frequent accompaniment of organic cardiac disease,

especially when involving the right side of the heart. The liver in this condition is somewhat enlarged, its lower border being rounded in outline and projecting for some distance below the ribs into the abdominal cavity. More or less catarrh of the bile-ducts is usually present. The portal vein and its tributaries are full and the circulation sluggish. The complexion is earthy or dusky, the conjunctivæ tinged with yellow, the tongue coated, and the bowels usually constipated. Drowsiness in the afternoon is a common feature, and the patient may complain of fulness in the head after eating, with dizziness and vertigo at times. Hygienic and dietetic regulations, with the various forms of active and passive exercise, are of prime importance, and they are often materially aided by judicious medication. There will be found a considerable proportion of obstinate cases in which mineral waters are of the utmost service, and must, indeed, in some instances supersede other methods of treatment. Those proving most useful are the bitter waters containing the alkaline sulphates and the chloride of sodium, and the bicarbonated magnesic waters. These appear to act by promoting the liquefaction of the bile, increasing its flow, stimulating the intestinal secretion, and exciting the peristaltic action of the muscular coats of the bowel. A considerable period of rest with quiet and peaceful surroundings, and a careful diet, should follow all courses of the stronger purgative waters.

Renal Diseases.—Simple pure water is an active diuretic, not only increasing the liquid flow of the urine, but, if taken in large quantities, greatly augmenting the amount of solids—urea, uric acid, etc.—escaping from the system. It thus aids in the process of metabolism or tissue-metamorphosis, and may be said, so to speak, to flush the system. Water in large quantities thus becomes useful in certain kidney diseases characterized by stagnation of the renal circulation and suppression of the urine. The same may be said of the water of many mineral springs. The effects of these agents have been wofully exaggerated by enterprising spring managers, but it is not to be doubted that genuine mineral waters of the proper class do exert a favorable influence in certain conditions in which nephritis is present. When the urine is scanty and high colored, and when it is acid in reaction, one of the milder alkaline or calcic waters may be administered in considerable quantities with undoubted advantage and with entire safety. As some of these waters, however, have sufficient mineral ingredients to make them active renal stimulants, the same discrimination must be exercised in their exhibition as in the case of the pharmaceutical diuretics. It has been shown that any variety of mineral water has the power directly to lessen the amount of albumin in the urine.

Diabetes Mellitus.—A few years ago it was quite commonly

believed that we had in some of the mineral waters remedies by means of which we could successfully cope with this formidable and mysterious affection. Continuous experience, however, has taught us the fallacy of these expectations. It is undoubtedly true that in the milder forms of glycosuria a course of treatment at some one of our spring resorts often results in a diminution or temporary disappearance of sugar from the urine. But these results are no doubt to a great extent due to the watchful dietary regulations in vogue at such places, and to the temporary change of environment and escape from the worries and anxieties of home. The alkaline and calcic waters have enjoyed the largest share of celebrity in the treatment of diabetes. "Under their use the diabetic gains in strength, the harassing cough ceases, the skin becomes moist, the urine is reduced to almost normal specific gravity, and often every trace of sugar disappears."[1] Althaus[2] informs us that in some instances the disease has been brought to a standstill for years by the use of the Vichy waters. The alkaline and sulphated saline waters should have preference in the frequent cases met with in corpulent and gouty persons. The light arsenical waters of Virginia have appeared to the writer to be best adapted to the milder cases of glycosuria. Whatever benefit we may attach to the use of mineral waters, however, cannot justly be attributed to any specific influence, but to the resulting improvement in digestion and assimilation.

Rheumatism.—There are few mineral waters which have not been recommended for rheumatism, either internally or by means of baths. This universal commendation, while no doubt overdrawn, in some instances is not without foundation. An obstinate case of chronic articular or muscular rheumatism may very properly receive a trial with some form of mineral water. One of the alkaline carbonated or lithic waters may be taken daily as a matter of habit. Such waters are also useful in the condition known as rheumatoid arthritis, with painful nodular swellings, especially of the joints of the fingers. They may be taken all the year round at home as well as at the springs; but the conjoined use of hot-water, mud, or peat baths promotes their efficacy. A water containing a small proportion of iron and arsenice is also valuable in these conditions.

Gout and the Uric Acid Diathesis.—In accordance with the most recent, but still somewhat obscure, researches of biological chemistry, an excess of uric acid in the blood is liable under certain circumstances to crystallize in the tissues, chiefly as the urate of sodium, giving rise to the painful swellings, especially in the greater tarso-metatarsal articulation, which characterize the initial stage of

[1] Walton's *Mineral Springs of the United States and Canada*, 1883.

[2] *Spas of Europe*, p. 320.

acute articular gout. These gouty deposits may also occur in the muscular structures, in the walls of the stomach, the cartilages of the ears and nose, the vocal cords, kidneys, etc. In the early stages of gout mineral waters are of no avail; but after the subsidence of the paroxysms, the uric acid tendency having been recognized, certain waters will be found to possess a potent influence in correcting the abnormal state of the blood, which is liable at any moment to renew the acute mischief. Two classes of waters are now useful: first the alkaline-saline waters, to form soluble compounds with the uric acid deposits; and, secondly, the sulphated or bitter waters, to favor their speedy expulsion from the system by stimulating the emunctories. It is not unusual to find the water of one spring possessing all the elements needful for this double purpose. A moderately strong sodic, lithic, or magnesic alkaline water may be taken for a long period without giving rise to the alkaline dyscrasia, and with a continuance of its good effects in eliminating the *materies morbi* of the disease.

Uric Acid Gravel and Calculi.—These bodies are in nowise dependent upon disease of the urinary organs, but originate, as does gout, from a defective elimination of the organic nitrogenized substances from the system. A calculus may be described simply as an overgrown gravel-stone; being due to the same causes and composed of the same elements as the smaller bodies. They may be divided into the uric and oxalic acid forms of deposit, probably two-thirds of the whole number, and the phosphatic or alkaline variety. Occasionally all these elements are found in a single stone. Sometimes the material of gravel and calculi disintegrates spontaneously and escapes in the form of "sand," giving rise to no inconvenience. In the red, or uric acid, gravel the alkaline waters are of undoubted utility. Their good effects are produced in several ways: First, they aid in the correction of the constitutional vice which gives rise to the production of the concretions. Secondly, by their diuretic and diluent action they palliate the local symptoms of catarrh and inflammation. Thirdly, they are believed by many to aid in the breaking down and chemical decomposition and solution of the calculi, thus favoring their easy draining off with the urine. The widely advertised lithic waters are credited with the possession in an unusual degree of this power. Calcic waters act well in uric acid gravel and calculi; and are the chief reliance in phosphatic deposits. Authorities agree that in calculous diseases mineral waters should be taken freely—four, six, eight, or ten glasses daily, and continued for a considerable period of time.

Enlarged prostate, Gleet, Vesical Catarrh, and Chronic Cystitis.—The milder alkaline-saline waters have been used with advan-

tage in these conditions. By their diuretic and diluent influence, and by maintaining the urine in an alkaline state, they serve to allay the urinary irritation which is apt to be present. The fact seems to be well established that in the advanced stages of the common scaly cutaneous affections, viz., eczema, psoriasis, and pityriasis, the alkaline waters are notably beneficial. The good effects are also observed in acne. The arsenical waters also possess high claims for utility in these disorders.

Scrofula or Struma.—These terms do not possess the wide significance which they did some years ago. There is, however, still a considerable class of cases marked by nutritive disorders of the skin, bones, and joints, which are properly referred to as scrofulous or strumous. These cases are readily identified by the observant practitioner, and require no description here. Without considering the many local manifestations of scrofula which usually require surgical aid, we can in various ways oppose the diathesis by hygienic and dietetic measures and by internal medication. The use of mineral waters properly enters into the last-mentioned method. The testimony of trustworthy medical men for many years past attests the value of the alkaline, carbonated, and chloride of sodium waters in strumous conditions. The iodine and bromine waters have also occupied a high place in this connection, but on account of their extreme tenuity we must accept statements regarding the efficacy of most of this class of waters with reservation. It cannot be gainsaid, however, that the chalybeate and arsenical waters are valuable in some cases, chiefly, no doubt, on account of their influence on nutrition.

Chronic Malarial Toxæmia and the Paludal Cachexia.—In certain sections of the United States, notably in Virginia, some of the stronger sulphurated chalybeate waters are credited with a specific influence in these conditions. To the arsenical waters, especially on the Pacific Coast, are also attributed the virtue of eliminating the vestiges of chronic malaria or paludism from the economy after the futility of ordinary remedies has been proved. The iodic waters are esteemed as promoting the reduction of splenic enlargement and effecting the removal of other evidences of the paludal cachexia. No mineral water, however, has been shown to possess the power of destroying the plasmodium malariæ. The good effects of these waters are no doubt due to the tonic and restorative elements they contain, and in some cases to the favorable circumstances of climate, scenery, etc., under which they are consumed.

Syphilis.—This disease and some of its sequelæ are often benefited by a systematic course of sulphurated and thermal baths, but it is doubtful whether we can do more than render a very moderate assistance to the pharmaceutical preparations by the internal use of mineral

waters. Much has been claimed for the iodo-bromated waters in the treatment of this disease, but the proportions of iodine and bromine are so small as to arouse feelings of skepticism regarding their efficacy. The light alkaline-chalybeate class of waters are useful in overcoming the debility and tendency to cachexia often observed in this disease, but no course of mineral waters should in any case replace or supersede the well-defined methods of drug treatment so long in vogue and the efficacy of which is unquestionable.

Obesity.—A tendency to corpulency, whether or not attended by the full habit, is benefited by a morning draught of one of the saline sulphated waters. Adiposity is also retarded by a liberal course of the alkaline saline waters, which promote eliminative metabolism. The use of thermal baths is, however, a more rational method of overcoming this disagreeable condition. All other forms of treatment should, however, be secondary or supplemental to a carefully abstemious diet, including the omission of sugars, carbohydrates, etc., conjoined with carefully graded exercise.

Chronic Metallic Poisoning.—In chronic lead-poisoning the sulphated saline waters are recommended as forming an insoluble and inert sulphate of lead. Sulphureted waters are prescribed for the same purpose, as well as for copper-poisoning. The bromine waters are also suggested—somewhat dubiously, we think—for lead and mercurial toxæmia, as forming *soluble* compounds with these metals, which are thereby readily expelled.

Diseases of the Respiratory Organs.—Mineral waters have not acquired much prominence in the therapeutics of respiratory affections, yet they may find a useful application in some of the chronic conditions affecting the bronchial tubes and lungs. No one would be inclined to question, for example, the utility of a palatable and easily assimilable chalybeate water in the early stages of phthisis, though, of course, this should not be relied upon to the exclusion of more positive forms of treatment. It is well known that such cases often thrive remarkably at some of the chalybeate spas. In the tardy convalescence and imperfect resolution sometimes observed in pneumonia, especially of the lobular or catarrhal type, spa treatment is often valuable. Muriated saline, alkaline, chalybeate, and sulphureted waters are preferable here. Acid and alum waters have been recommended, with some show of reason, for night-sweats and hæmoptysis, while the alkaline muriated waters undoubtedly exert a favorable influence in the treatment of chronic laryngitis and clergyman's sore-throat. Good results have been reported from the liberal use of the arsenical waters in asthma. Iron and arsenical waters have also proved beneficial in pulmonary emphysema.

Diseases of the Heart.—Cardiac affections are not, as a rule,

amenable to treatment by mineral waters, but there are several conditions resulting from faulty action of the heart in which a proper water may be found very useful. In cases of general anasarca a properly gauged dose of one of the bitter waters will render as valuable a service as a dose of pharmaceutically prepared Epsom or Rochelle salt. Likewise, in valvular lesions, characterized by hepatic congestion and general fulness of the veins, we may gain a good result by their use. In the gastric catarrh of mitral lesions the mild alkaline-saline class of waters may be administered with entire safety, and often with good effects. In the functional cardiac disturbances resulting from anæmia and chlorosis, hyperacidity of the stomach, excessive smoking, etc., a light alkaline carbonated chalybeate water is indicated.

Nervous Affections.—The internal use of mineral waters is not to be relied upon in the treatment of the organic affections of the nervous system. They may, however, be employed in a number of functional disturbances—viz., headache, neuralgia, migraine, hypochondriasis, etc. Most of these phenomena being merely symptomatic, their rational treatment depends upon the associated condition to which they owe their origin. If nervous derangement be due to business worry, anxiety, or overwork, a few weeks' absence from home at some quiet rural resort, whether a spa or not, is useful. If an habitual sick headache is due to dyspepsia, constipation, or biliousness, we may expedite its disappearance by means of the alkaline-carbonated or sulphated-saline waters, as the case may be. If neuralgia is produced by anæmia, or cardiac palpitation by chlorosis, a chalybeate water should be chosen.

Female Pelvic Disorders.—In most European countries it is the custom for physicians to refer some of their obstinate cases of uterine trouble to one of the spas for a course of mineral waters or baths. Those best adapted to such treatment are cases of chronic congestion of the womb, obstinate perimetritis, and inoperable fibroids. The muriated salines for internal use and the thermal sulphureted waters for bathing and for the douche have been found most useful for such cases. The magnesic waters are of benefit in engorgement of the pelvic viscera accompanied by chronic metritis. Chronic corporeal or cervical catarrh and leucorrhœa are often much improved by the alkaline chalybeate and mild sulphureted waters. The lighter sulphated waters may be safely used in the constipation of pregnancy, as they have no tendency to produce uterine contraction.

The mild bicarbonated magnesic waters are of great value in the constipation of children, while at the same time they tend to correct the acid stomach of the dentition period.

MASSAGE AND SWEDISH MOVEMENTS.

By ROBERT E. MOORE.

Massage is a scientific manipulation of the tissues of the body, and consists in certain movements, such as stroking, kneading, beating, percussion, and vibration. During the practice of massage the patient should be in bed. A bed is best, because the benches which the Swedes use are built too high, being from four to four and a half feet in height, while with a bed or couch the masseur can get closer to his patient. Thus, after treating the foot, the masseur can take the foot in his lap, at the same time sitting down on the side of the bed; this elevates the leg from two to three inches, giving the masseur full control of the under and upper muscles from the ankle-joint to the knee-joint. After finishing the calf of the leg he passes on to the knee-joint, which is treated, and then the thigh is treated. All of this is done while the masseur sits on the side of the bed, without disturbing the patient. If a bench is used, this cannot be done. Massage should always be performed upon the skin with the bare hand.

Many masseurs use cacao-butter, which in my opinion is unwise. I have never used oils of any kind, nor have I ever resorted to shaving, as hair-pulling and irritating the skin can be avoided by stroking with the palm of the hand instead of with the balls of the fingers. Dry massage is cleaner, and it affords a better and more certain feeling to the hand, and the movements are steadier.

It is never necessary to expose the patient's body, as some people seem to think.

The time taken to give general massage is from thirty to fifty minutes, gradually increasing the time and reaching the fifty minutes' duration at the end of a week or ten days.

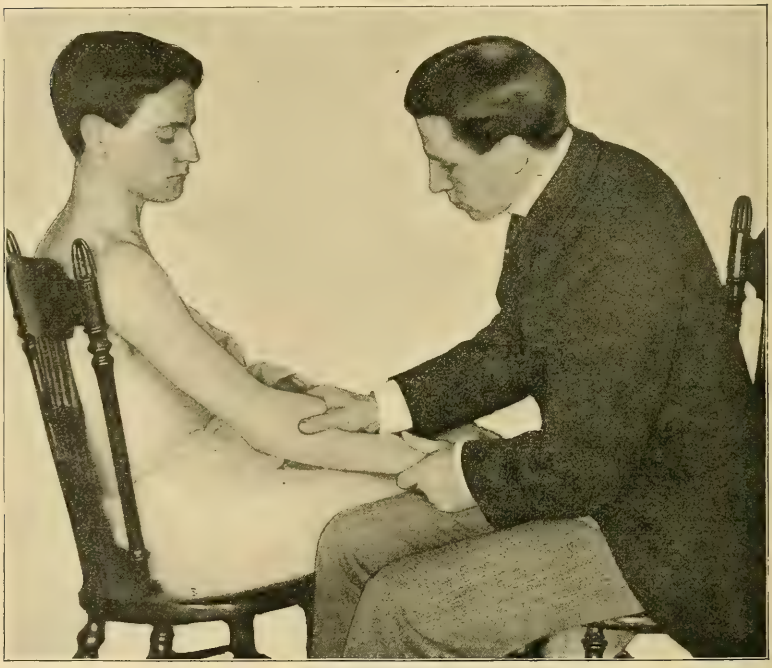
The various movements employed in giving massage may be described as follows:

Shaking.—This movement starts from the elbow-joint of the manipulator, where there is slight flexion, and extension. Between it and the ultimate phalanges of the fingers, the bones of the forearm, wrist, and hands, with their joints, act, and through them a wave-like motion is sent to the part worked upon. The movement of the

hand is very quick. The joints must not be kept stiff, and just so far extended that elasticity is permitted. This movement promotes and quickens absorption and it stimulates and strengthens the part affected.

Vibrations.—Vibrations are fine shaking movements. The whole, or part, of the palmar surface of the hand or fingers is used. As in shaking, there are flexion and extension movements at the elbow, but they are much more limited. The movements in the loose wrist-joint are abduction and adduction of the hand, which lies immovable so far as the part of the surface of the body on which it rests is concerned. Through the quick succession of the individual movements the vibrations are produced. If flexion and extension are allowed at the wrist, pressure is caused. The injurious influence of this in different localities, say over a weak heart, need not be pointed out.

FIG. 77.



Pétrissage with one hand.

Tapotement.—Tapotement means beating. Beating is performed with the closed fist applied to the fleshy part of the limb, with a loose and light movement of the wrist-joint. This treatment is good for hardening and strengthening the muscles.

Percussion.—This movement is performed with the edge of the hand and extended fingers, which are kept loose, and with a quick

motion of the wrist-joint the fingers are flung across the muscles. It is useful for hardening the muscles and quickening the circulation.

Slapping.—This is performed with the palms of both hands with a light motion of the wrist-joints, and is useful to improve the circulation, particularly in the extremities.

Muscle-rolling is performed by grasping the limb with the palms of both hands and making a quick, alternate pushing and pulling motion. This movement increases the circulation of the blood in the deeper tissues of the part.

Pétrissage.—Pétrissage is a kneading movement by which the skin, tissues, and muscles are acted upon. Pétrissage of the muscle may be done with one or with both hands. Fig. 77 shows how it is done with one hand. The muscle, or part of it, is grasped between the thumb and other fingers and rolled slowly between them, the pressure sometimes increasing, sometimes diminishing, care being taken that the joints of the fingers and wrist are kept loose. A stiff wrist impedes the free motion of the fingers and prevents elasticity in them. It is of importance in all forms of pétrissage that the skin under the fingers should move with them, as the manipulation otherwise is somewhat uncertain and less effective. In giving pétrissage with both hands, we use the whole palmar surface of the hands, most of the pressure being made by the heel or base of the hand. In this way the deep-seated muscles are reached. The use of the tips of the fingers and the thumb has been one of the commonest faults I have met with, especially among the Swedish operators. This use of the tips of the fingers causes hair-pulling, and the hair-bulbs become inflamed.

Effleurage.—This movement consists of centripetal strokings toward the heart. It is performed by the heel of one or both hands, and by the balls of the fingers and of the thumbs. Stroking with the heel of one hand is used upon the arms or legs, with the heels of both hands upon the chest and back, and with the balls of the fingers about joints in cases of old dislocations and fractures. Stroking with the balls of the thumbs is used between muscles or tendons attached to the hands and feet.

Pushing of the muscles is done by one or both hands laid firmly on the muscles, while the muscles are pushed to and fro. If performed with two hands, one hand should make an upward movement, while the other is making a downward movement.

Shakings at Lower Part of the Thorax.—The patient stands with the hands folded behind his neck. The operator places one hand on each side of the lower part of the thorax. With the palms he makes soft and quick compressions, alternating with relaxation. During relaxation the hands are not to be lifted from the thorax,

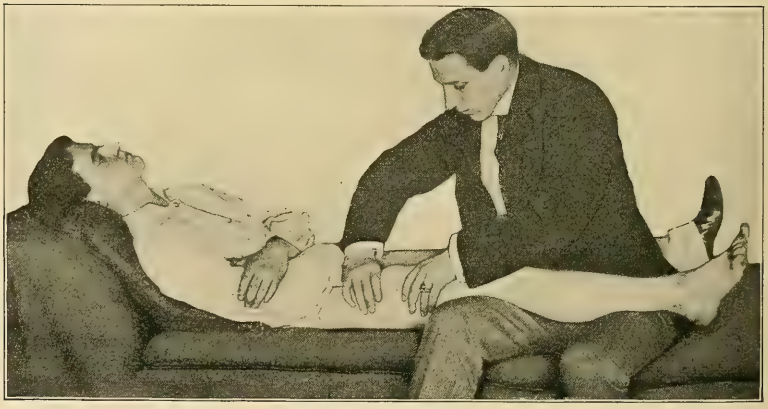
but should remain in close contact with it. The patient must breathe deeply. The ribs, being elastic, rebound when the pressure is removed, and the respiration becomes freer and deeper.

When general massage is to be given, the masseur grasps the left foot firmly but gently, stroking it three or four times, and then passes to the toes, which are then given pétrissage, or kneading movements. Effleurage, or stroking movements, are then given the foot and ankle.

FIG. 78.

Kneading the knee-cap.

FIG. 79.



Kneading the thigh.

Pétrissage, or kneading, is then given to the calf of the leg. This may be given with one or two hands. After these movements have been carefully employed effleurage and muscle-rolling or muscle-shaking are performed. The knee is now taken, and kneading, parting, rotating movements applied to the knee-cap, as shown in Fig. 78. Next the operator comes to the thigh, and gives this part effleurage, pétrissage, with rolling and shaking of the muscles, as shown in Fig. 79. The

right leg is now taken and given precisely the same movements. This is all done while the operator is sitting on the side of the bed. All movements should be made with the pressure upward.

After the legs have been treated, the hands and arms are given the same movements. The masseur now passes to the back. The patient should lie on his belly, a pillow being placed directly under the abdomen, as shown in Fig. 80. The arms are raised to the head, but no

FIG. 80.

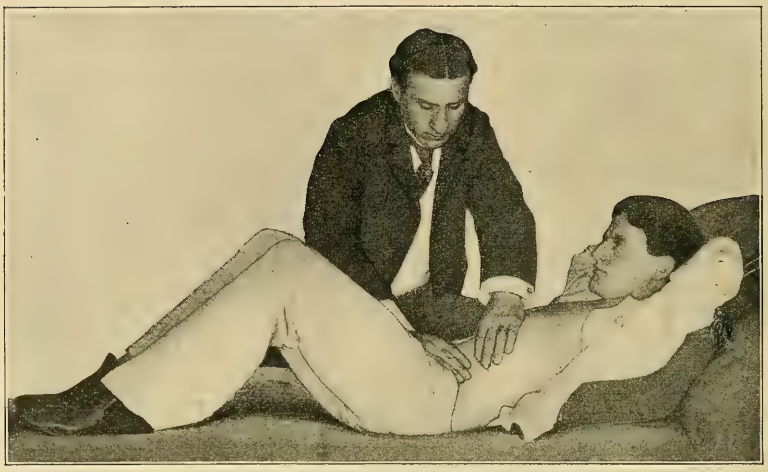
Kneading the back.

pillow is placed under the head. The reason for using the pillow under the abdomen is that the back muscles will otherwise be distorted from lying on the belly. Beginning at the base of the skull, the operator begins with kneading movements, using both hands, on either side of the neck and then stroking or kneading the whole back. I also use a pushing movement, placing a hand firmly on each side of the spine, pushing the muscles up and down, one hand going up while the other is making a downward movement. The sides of the trunk are now taken, starting at the armpits and finishing at the hips.

The gluteal muscles require very deep kneading and deep stroking with the heel of the hand, and also a great deal of kneading with the balls of the fingers and thumbs on either side of the spine, until the skin becomes pink. I do not approve of too much friction. Mas-

seurs, as a rule, use friction instead of pétrissage, as it is easier. Pétrissage is much harder work.

FIG. 81.

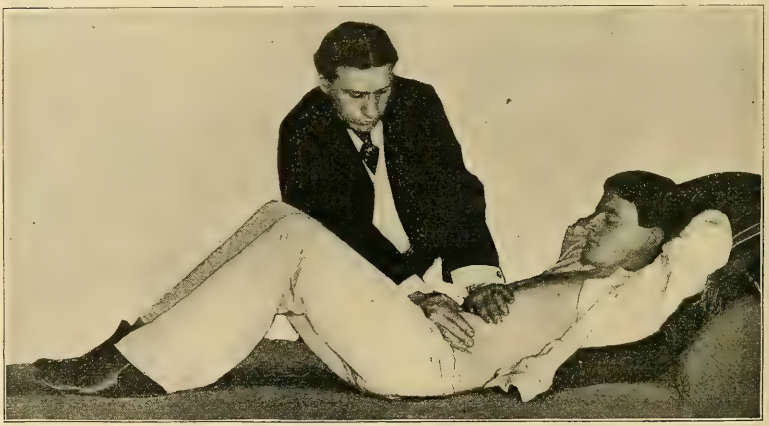


Kneading the stomach.

Parting the muscles of the back is done by placing a hand on each side of the spine and pressing outward. This is done with the heel of the hand entirely.

The next movement is a pulling or drawing movement, starting well under the patient's ribs and pulling toward one firmly. The back

FIG. 82.



Following the colon,

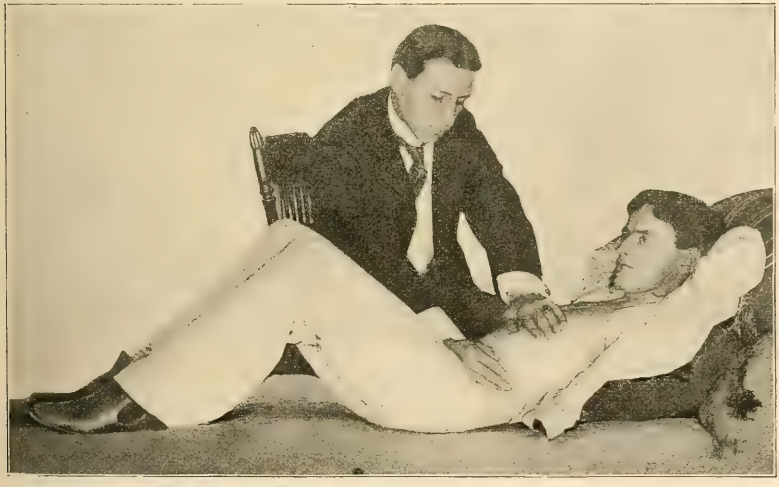
is then finished by stroking each side of the spine by crossing two fingers of one hand over two of the fingers of the other hand and applying

them to the surface. This movement should begin with the left hand, and as it reaches the end of the spine the right hand should be placed at the base of the skull. It is performed very rapidly, at the rate of about twenty strokes in ten seconds. The next stroking movement is made by placing both hands on the back, starting at the neck, with a circular motion. The muscles of the chest are now given pétrissage, rolling and parting movements, and also pushing movements—the same movements as were used on the back.

Massage of the abdominal contents is to be considered separately from that of the abdomen, because most masseurs do not pay any attention to the stomach, but all to the abdominal muscles. The operator should start with light kneading and deep friction and vibrations, as shown in Fig. 81. Light pétrissage should be used at first, directing all movements toward the descending and transverse colon. Deep stroking is made by the heels of the hands, first with the left hand around the colon, the right hand following in the same manner, as shown in Fig. 82.

Kneading movements are very beneficial for the liver, and vibrations and shakings are the most effective. These movements are

FIG. 83.



Vibrations of the abdomen.

shown in Figs. 83 and 84. The patient should be in a standing position when shakings are given to affect the liver.

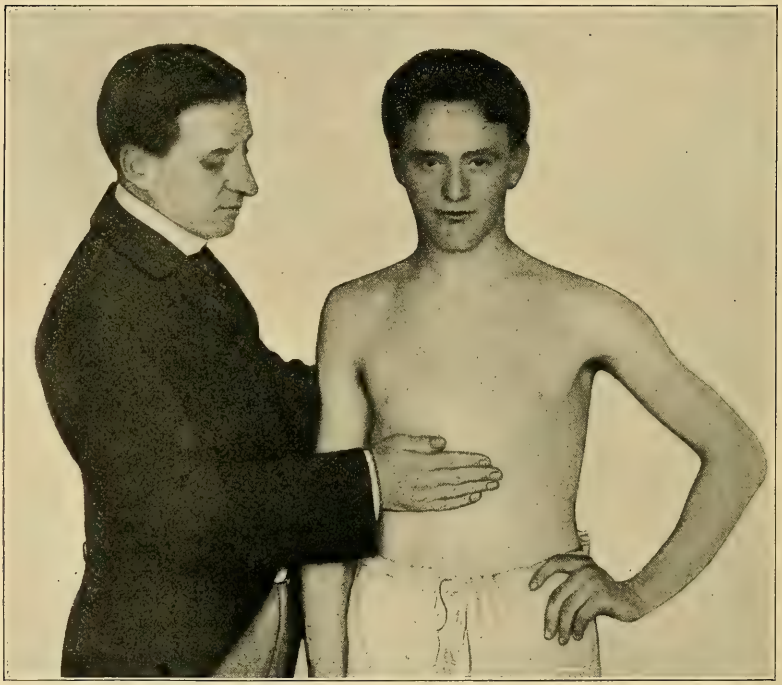
The throat movements that are used are mostly stroking and kneading. Vibrations are used also, and with very good results. As there are many glands in this region, it may be pointed out that whenever enlarged glands are treated vibrations should be used.

Among the special massage movements which are beneficial to local

portions of the body, we may next consider vibrations of the thorax, which are given in many cases of disease of the lungs. The vibrations pass through the thoracic walls to the lungs, which they stimulate and strengthen. These movements produce free expectoration, followed by diminished irritation, promote rest and a feeling of ease, and when given with frictions between the shoulder-blades also reduce congestion and inflammatory conditions.

Vibrations over the heart must be given very carefully, the hand being placed lightly over the apex; and a masseur should never give

FIG. 84.



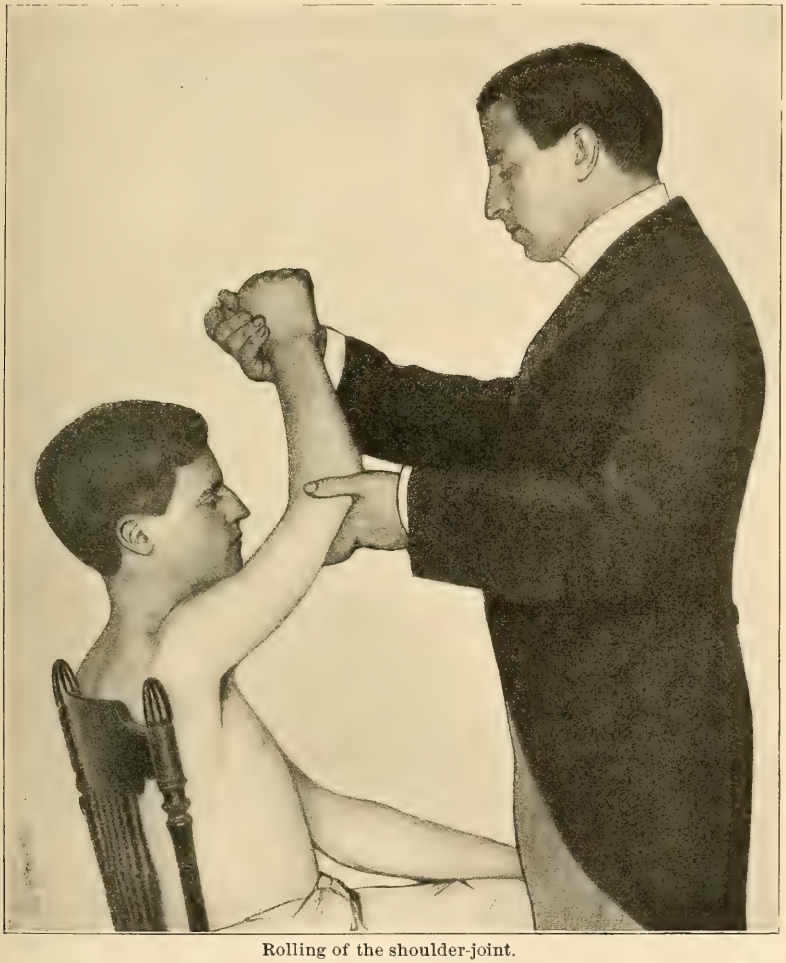
Shaking movement for the liver.

vibrations unless he understands how to do so properly, for great harm may be done if they are unskilfully performed. A weak heart has enough to do, and if a heavy hand is added, and rendered still heavier by a stiff arm, the patient is not benefited. The patient must lie down, with the hands placed under his head; the chest should be well thrown out, and the patient should raise the knees, so as to relax the abdominal muscles, which is very necessary, as all muscles should be relaxed when being treated.

When rolling of the head is resorted to, the patient sits on a chair and the operator stands to one side; the left hand is placed on the fore-

head and the right hand at the base of the brain. This hand is kept nearly immovable while the other hand performs the movement of turning the head from left to right. The rotating movements are performed by both hands being equally active. Before the head is bent forward it is slightly inclined backward, and the hand on the forehead makes light vibrations, which help to aid the flow of blood from

FIG. 85.



Rolling of the shoulder-joint.

the head. In all these movements the head is sifted up or extended on the neck before the exercise commences. The object of this is to draw the blood from the head, as well as to take stiffness out of the neck.

For the purpose of using rotation or rolling of the shoulder-joint, the patient sits while the masseur stands in front; the elbow rests in the operator's left hand, and he grasps the patient's wrist with his right, the hand on the elbow acting as a guard, as shown in Fig. 85.

When rolling of the hip-joint is performed, the patient lies on his back. With one hand the operator grasps the heel, with the other the knee-joint; and while the hand on the foot executes the movement, the other acts as a guide.

For rolling of the ankle-joint, the patient's leg is placed over the masseur's knee so that the ankle comes just over it, or it can be done by the patient lying in bed with a pillow placed under the ankle-joint. The ankle is grasped with the left hand and the right hand does the rolling.

The number of times these movements must be made varies with the part, and also with the condition of the joints. We cannot roll the head as much as an arm or leg.

In cases of sprain of the ankle it is to be recalled that if it can be worked upon within an hour or two after the injury we can very often keep the patient out of bed. In treating such a sprain, if very painful, we begin gentle kneading at the knee, gradually working toward the ankle, all movements being directed upward. After *kneading* the foot for ten minutes, stroking and light rotation of the joint should be used, followed by extension movements, these movements being made from six to eight times very slowly. After this is done the operator may start again with the kneading and stroking, which can be kept up for five minutes, alternating with the extension movements until thirty minutes are consumed.

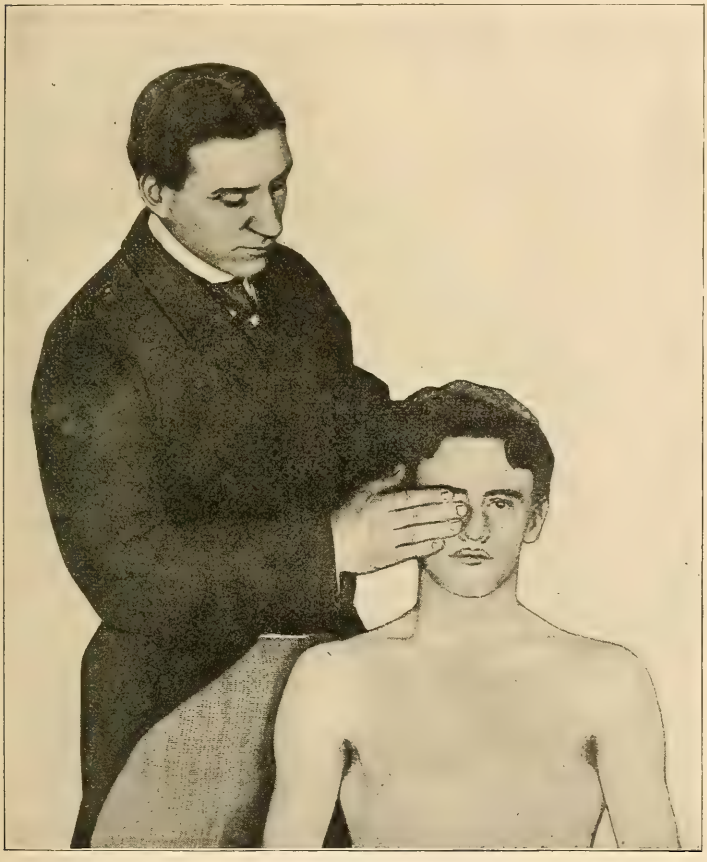
Massage is one of the most important factors in the treatment of joint-diseases, and this treatment makes large demands on those who practise it, and should never be carried out except by a skilled masseur. Simple joint-diseases of different kinds, such as dislocations, contusions, and sprains, should be given massage immediately after the injury, or the reduction in case of luxation. And if the condition is severe, one must be prepared to work faithfully every day for weeks, perhaps for months, before he sees any great or satisfactory results. In every case the rule holds good not to consider the joint alone when using massage, but the muscles as well.

For the removal of parallel lines and grooves of flesh seen in the foreheads of people addicted to deep thinking and frowning, the first massage movement consists in an upward and outward movement of circular motion on the forehead with the thumbs of both hands. The second movement is done with the thumbs in an upward and outward direction for the deep horizontal lines which cross the forehead in every direction. More energy can be expended on the cheeks than would be desirable or permissable on any other part of the face. The rubbing is done with the thumb and first finger of both hands in a series of kneading circular movements all over the cheek. These movements

must always be *upward*, not downward. Downward movements are bad for the symmetry of the face.

For the removal of the little network of lines which usually make their appearance under the eyes, the correct movement is accomplished with the tip of the second or first finger (Fig. 86). The

FIG. 86.



Vibrations of the eyes.

motion must always be from the inner corner of the eye outward, with a gentle circular curve toward the temple.

For the small lines which appear on the sides of the nose on so many faces, and which are usually caused by a facial habit or trick in talking or laughing, the best treatment is with the tips of the second fingers both in an upward and a crosswise direction. The movement must be very gentle, or more harm than good will be the result.

In many women when they reach a certain age the upper lip has

a tendency to fall in. This falling in ruins the symmetry of the face. Massage properly administered is the best preventive. It must be done gently with the tips of the first and second fingers, and always in an upward direction.

Massage for the chin must be always downward, so as not to disturb the symmetry of the mouth. More force can be used in this movement than in any of the others, except that given to the cheeks, as the flesh on the chin is usually firm and can stand good, strong manipulation with the thumbs. The flesh immediately under the mouth must, however, be very gently massaged, and always in an upward direction, so as not to pull down the corners of the mouth.

Some people seem to think that they cannot stand massage every day because they are not strong enough, but this is incorrect. Massage should be applied once, sometimes twice, a day, in order to get the most beneficial results. The good which is derived from one treatment should not be lost before the next treatment is given. It is the treatment which builds up the patient's strength; but if tried only once in a while he will feel tired and stiff a day or two afterward, and naturally think that the treatment does him harm, just as a man who takes a five- or ten-mile walk once a week or exercises once a week for one hour feels sore and stiff after each time.

SWEDISH MOVEMENTS.

THESE exercises are for the purpose of preserving and increasing health, warding off sickness, and in many cases they may also be used as a cure in certain conditions of ill-health. They are particularly useful in relieving weakness of the organs of respiration and digestion, and for the purpose of reducing corpulence; but it is always well for the patient to consult a physician before beginning such exercises. The accompanying illustrations have been prepared by means of photographs taken especially for this purpose, and are therefore pictures from life of exercises actually performed.

Swedish movements, if they are to be of decided benefit, must be performed with absolute regularity. They must be taken daily. The time for daily exercise by younger children and weakly persons should be from fifteen minutes to half an hour; persons of greater vigor and training may extend it to an hour. They should be continued with steady perseverance for a long time for an effect to be attained. A person looking for striking results in two or three weeks will be disappointed, as it requires a longer time than this to cause marked improvement. The movements should be carried out with

attention and will-power, with muscles tense, and exactly according to the form prescribed in definite number each time. The number of movements vary according to the strength of the individual.

After a certain number of movements have been made, a pause should follow for rest, during which there should be quiet and deep breathing.

If after any exercises palpitation of the heart occurs and respiration is much quickened, then both should be entirely quieted before the next movement is begun.

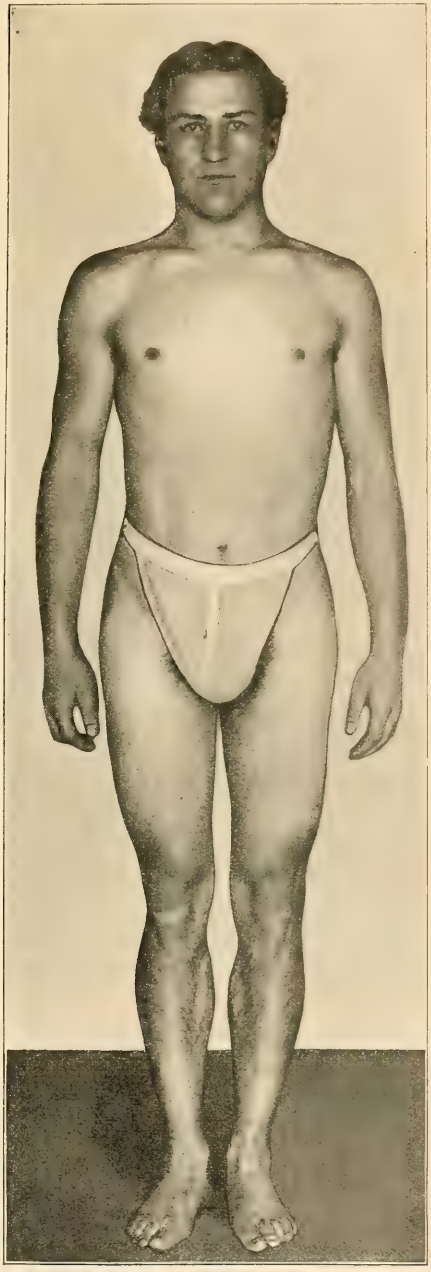
The total effect of daily exercises is a moderate, pleasant fatigue, for the patient should never tire or be completely exhausted. Each period of exercise should begin with movements which call for moderate exertion only. Afterward the more vigorous movements should follow, and the séance close with gentle and quieting movements.

Only by degrees should the exercises be extended to the more difficult movements. Weak persons especially should pay attention to this. For older people the more quiet movements are, as a rule, the only ones to be employed.

Young children should take the exercise in gentle forms with little expenditure of energy.

It is desirable that the organs of digestion should be as empty as possible when the exercises are taken. The gymnastic exercises should be so

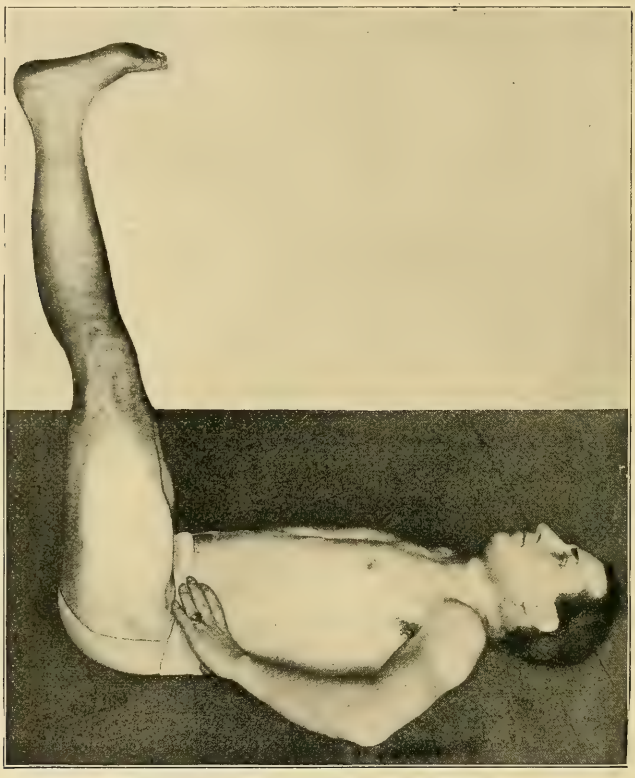
FIG. 87.



Correct position before beginning exercise.

arranged as to precede the meals. The morning hours before breakfast is the best time for them, but any time during the day before a meal will do, always allowing a short interval between the exercises and the meal following. Sometimes the late evening hours are desirable when we wish to induce sleep. The intestines and bladder should as far as possible be empty during the exercises, a precaution to which special attention should be paid.

FIG. 88.



Raising of the legs while lying on the back.

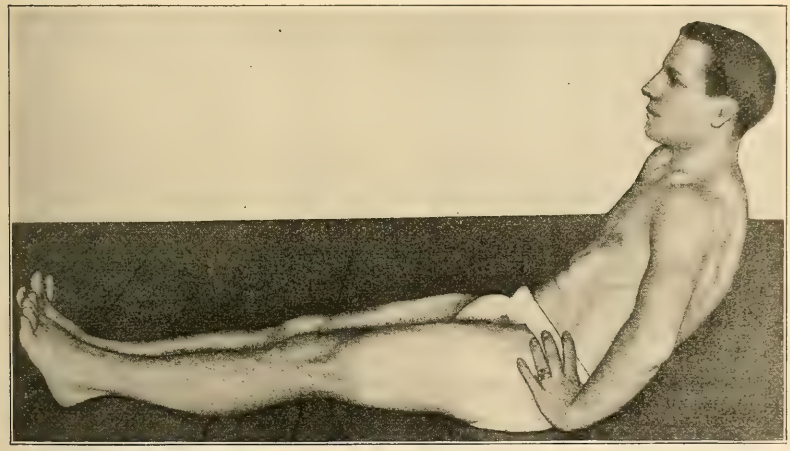
The windows of the room may remain open during the exercises even in the severest weather if there is no draught, and if the necessary precautions are taken to avoid exposure. Exercise should always be taken in loose garments, so that all movements of the body are unimpeded, and anything tight about the neck, chest, hips, or abdomen should be removed.

The position to be taken in beginning the exercises is first to place the heels together—that is, from two to three inches apart, with the toes pointing outward, the legs being firm and the head

kept erect, as shown in Fig. 87. The arms should hang at ease at the sides of the body.

When a muscle contracts the veins and lymphatics are necessarily compressed and more or less emptied, and as soon as the muscle relaxes there is an increased flow of blood into it and consequently greater nourishment and growth of its fibres. If the contraction is repeated time after time, taking care, of course, that it is always kept within limits, so that the muscle is not exhausted, a development of new muscular fibre takes place, and as a consequence of these two processes the muscle becomes stronger and capable of doing more work. All active movements have the effect of building up and strengthening the tissues. A correct position is nearly of as much importance as the movement itself. By that I not only mean a position in which the exercises can be best executed, but also one in

FIG. 89.



Raising the trunk to a sitting position.

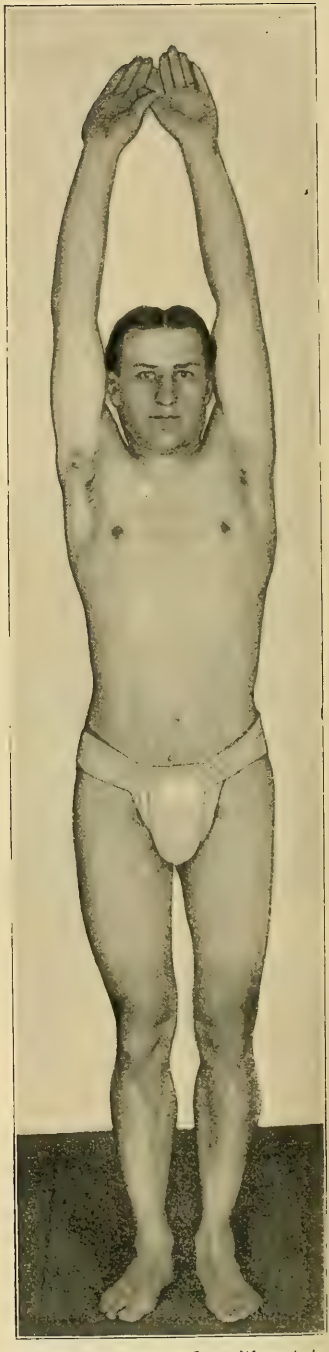
which the chest is free while deep and steady respiration must be kept up. Simultaneously with the quickening of the circulation a greater amount of blood is sent to the lungs, carrying with it more carbonic acid, and the distribution of oxygen in the body is increased.

Turning to a consideration of the individual movements, we come first to those involved in raising the legs or the trunk while lying on the back. These two movements are shown in Figs. 88 and 89. First, the patient lies flat on his back, as in Fig. 88. He lifts the legs up to a right angle or more with the hands on the hips, while the head is kept on the floor, and takes deep respirations. The movements are made very slowly, and the patient stops at different angles. This greatly increases the muscular work. This movement can be made from four to eight times. In the next movement (Fig. 89) the

FIG. 90.

Exercises for the trunk-twisting.

FIG. 91.

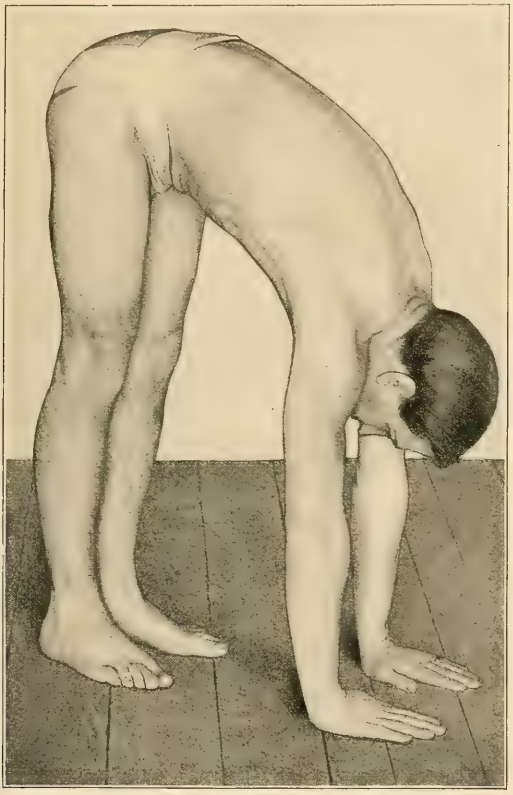


Trunk-bending forward, position at start.

patient lies flat on his back putting the hands on his hips, and then gradually raises the trunk until he attains a sitting position. Sometimes the patient may steady himself while raising the trunk by placing the toes under a bureau or chest of drawers. Patients are often inclined to throw the shoulders forward, thus compressing the chest. This should be avoided. These exercises are very beneficial to the organs of the abdominal cavity.

The position for exercises for the trunk are as follows: The

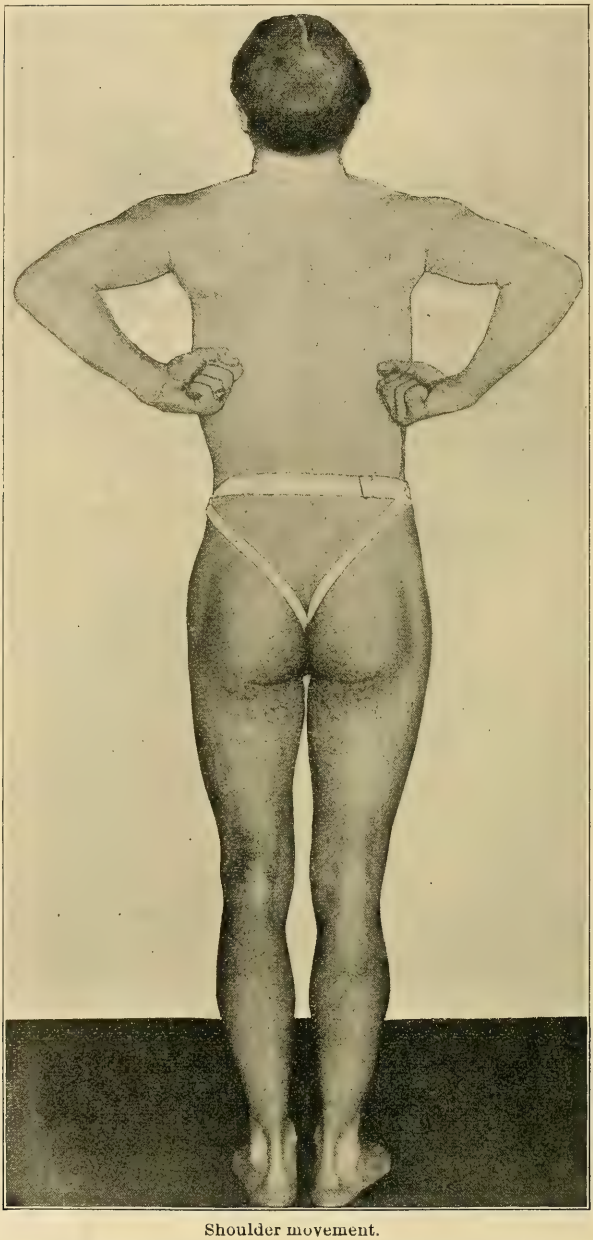
FIG. 92.



Trunk-bending. Touching palms to floor.

patient stands so that the heels touch, the hands are placed on the hips, the feet firmly planted on the floor, and the legs are made rigid. The upper part of the body is twisted alternately to the left and to the right as far as possible, the head following this movement as shown in Fig. 90. This movement affects the side muscles of the abdomen and the muscles of the hips, and produces in them invigoration and an improved circulation. Another useful movement is that of trunk-bending (Figs. 91 and 92). The arms are stretched

FIG. 93.

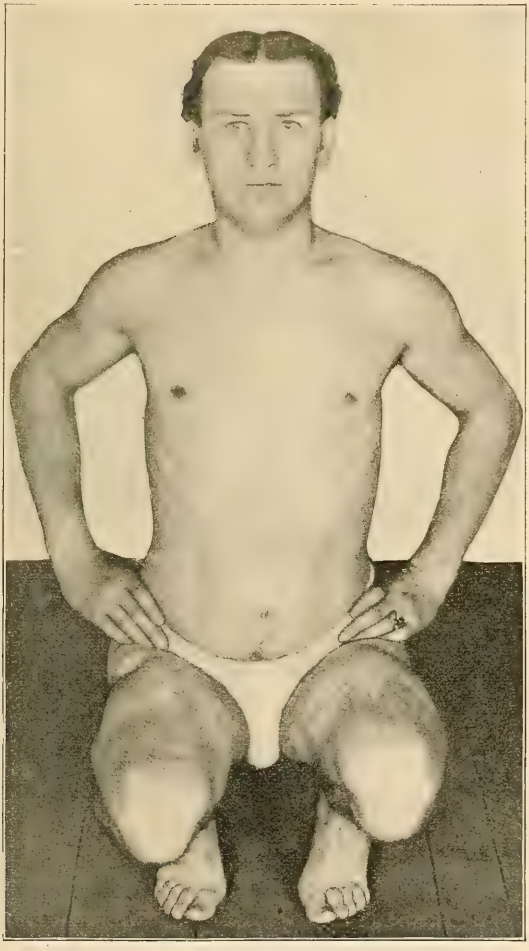


Shoulder movement.

over the head, palms turned outward, and the legs are made perfectly rigid. Before this movement begins the patient stretches himself to the utmost. Then he slowly bends forward. The back is not to be

kept straight while he does so, because the segments of the vertebral column then become immovable. The movement which takes place is greatest at the hip-joints. It is a falling forward of the trunk, gradually passing from vertebra to vertebra, until the patient can touch the floor with the tips of the fingers. This movement is to be persisted in till the patient is able finally to lay the palms of the

FIG. 94.



Deep knee-bend.

hands on the floor. While performing this movement the patient should draw in the abdominal wall to the utmost, then take a long breath, and slowly straighten up again. The breath should be released without relaxation of the abdominal wall.

In performing the shoulder movements (Fig. 93), the arms should

be stretched out horizontally, with the fists closed. Then the arms are brought back gradually, the fists being placed under the shoulder-blades, with the fingers pointing upward at the same time and contracting the muscles of the arm. Long, deep inspirations should be taken while doing this movement. This is a good movement for overcoming protruding shoulder-blades, for relieving a relaxed carriage, and for curvature of the spine.

The deep knee-bending movement is carried out by placing the

FIG. 95.

Trunk-bending sideways.

hands on the hips, the upper part of the body being kept erect. The legs should now be bent as low as possible until the buttocks almost touch the heels; the heels are then raised as high as possible and must be kept together (Fig. 94). This is an excellent movement for all the joints, including the hip, the knees, the ankles, and the toes.

The lateral bending movement of the trunk is performed as follows: the hands are placed together and raised above the head, the patient taking a long breath at the same time. Then the arms

are slowly allowed to descend, and the body is bent laterally until the fingertips touch the floor, first the right side, and then the left, as shown in Fig. 95. This movement promotes the activity of the internal organs, especially the liver.

The patient is best taught how to breathe by following the directions seen in Fig. 96. Vigorous breathing is best accomplished in a standing position, with the arms at the sides of the body, or the hands laid loosely on the hips. The chest should be slowly expanded to its full extent, allowing a large amount of air to stream into the lungs. When at the height of inspiration, the greatest expansion of the chest being reached, the breath should be held for a moment, and then allowed to leave the lungs slowly but completely. The inspiration and expiration should take place through the nose, with the mouth shut.

FIG. 96.

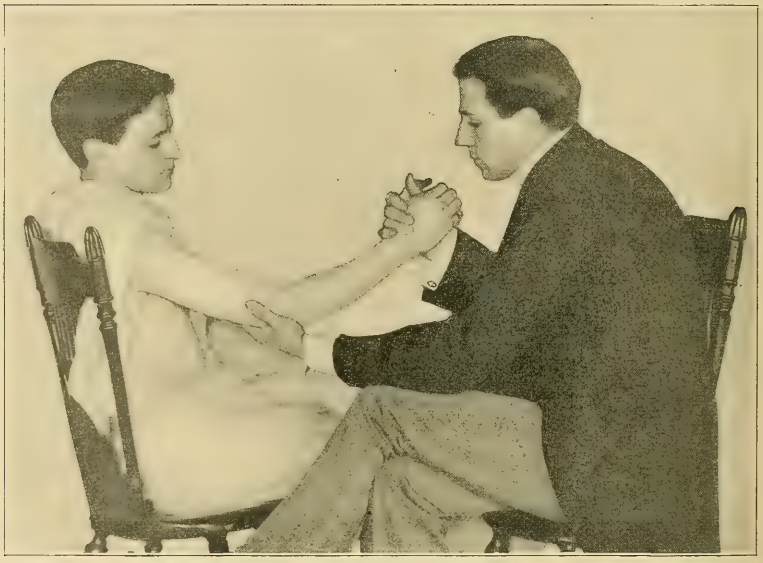
Correct position for breathing.

For the purpose of improving the muscles of the arm involved in the movements of flexion and extension, we employ the movements shown in Fig. 97. The patient first stretches and bends his arm at the elbow-joint against resistance offered by the operator. Then the operator stretches and bends the arm during the

resistance of the patient. This develops and strengthens the flexor and extensor muscles of the arm and increases the circulation in them.

Another arm-exercise is arm-thrusting. Preparatory to the thrust the forearms are lifted to a horizontal position, and the elbows are drawn so far back that the wrists come into line with the surface of the chest. The fingers are closed into fists; the shoulders should not be lifted. When in this position the fists are thrust forward, sideways, upward or downward in a straight line, by stretching the arms vigorously and quickly. The fists should be bent outward in the lateral thrust, and upward in the upward thrust. To do the thrust-

Fig. 97.



Arm flexion.

ing downward very energetically, the elbows should first be lifted upward, then the thrust follows. This also exercises the abdominal muscles.

In still another movement the arms are raised sideways into a horizontal position, the forearms being bent forward till the ends of the fingers touch. Then the arms are moved backward on a level with each other to a horizontal position. This should be done at full stretch, and as far backward as possible, either slowly or with a swinging motion. This exercise may be performed with both arms, or alternately first on one side and then the other. Besides bending and stretching the muscles of the arms, these exercises are good for the muscles of the chest, the shoulders, and some of the dorsal mus-

cles attached to the shoulder-blade. They render the elbow-joints limber, expand the chest, and improve any defects of its formation.

Leg-raising may be done as follows: The hands resting on the hips, either leg, which must be fully extended, is raised sideways, forward, and backward as far as possible, and without bending the body, which must be kept erect. After remaining a little while in this raised position the leg is again lowered slowly. The supporting leg should remain perfectly rigid and should not be bent.

In leg-swinging, either leg is swung energetically forward and past the other leg, and then backward with equal force. These exercises of leg-raising, leg-spreading, and leg-swinging are performed by the aid of numerous muscles which lead from the pelvis to the upper thigh. They have an invigorating effect on these muscles, render the hip-joint more supple, remove an excess of blood from the head and chest, and also from the organs of the abdomen.

In knee-raising forward and leg-stretching, the knee is raised so high that the thigh is at least in a horizontal position while the trunk is held upright. The lower leg hangs vertically down, with the foot bent slightly upward. In this position the whole leg is quietly but vigorously extended, and with it the foot also. The thigh should not be lowered enough to make full extension of the leg impossible. The supporting leg should continue rigid during the exercise. The act of raising the thigh is exciting to the circulation of the blood in the organs of the pelvis and to the peristaltic action of the lower intestines.

In raising the lower leg, the left or right lower leg is raised backward by a movement of the knee-joint, and lowered again by straightening the leg slowly. The thigh of the bent leg should be held in a vertical position close to the supporting leg. The knee should not be bent forward. This exercise makes the extensor and flexor muscles of the lower leg active and the knee-joint supple.

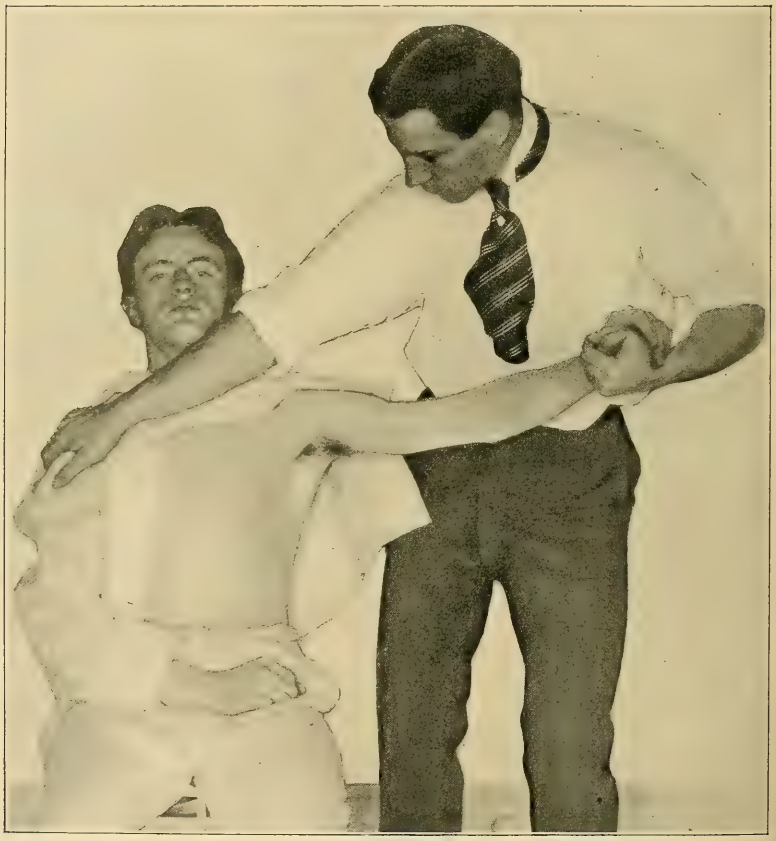
In the movement of chest-dipping, the body is supported by resting the hands on the edge of the seat of a chair. Then a backward movement is made. The head, trunk, and legs should be in the same line, and the arms at full length; while thus supported the arms are bent and straightened again. In doing this movement one should be careful that the body does not lose its upright position. This posture, with its accompanying arm-bending and arm-stretching, acts very extensively on the muscular system of the trunk, also on that of the arms and legs; but this exercise calls out more particularly a vigorous activity of the dorsal muscles. These exercises are also useful in cases of relaxed and crooked carriage. The bending of the arm in support in lying forward also enlarges the chest and improves the activity of respiration. It is also useful in cases of

defective formation of the chest and defects in the organs of respiration.

For the development of the muscles of the neck we use head-torsion. The patient stands in an erect position and the head is turned alternately to the right and to the left, consequently around the axis of its length, so that the patient looks over the right and then over the left shoulder. In doing this movement it must be remembered that the shoulders are not to be moved.

In head-bending, the head is bent forward, and if possible so far that the chin touches the chest lightly without the least twisting, and

FIG. 98.



Breaking adhesion of elbow-joint.

with a regular, steady movement in which there must be no jerking. After remaining a short time in this bent position the head is raised till it is again erect. The backward bending is done in a corresponding manner. The upper part of the body, and especially the shoulders, should be kept quiet and entirely passive.

In head-rotation, the head is first bent forward then turned sideways to the left, then backward, then sideways to the right, and again forward in the opposite direction. The movement is a continuous one, and must be done regularly and steadily. By these movements of the head the muscles of the throat and neck are exercised and invigorated. These movements are good in cases of paralysis and weakness of the muscles of the neck, and also for wrong positions of the head, especially when the head is held on one side.

Passing to a consideration of distinctly pathological conditions which may be relieved by Swedish movements, we find in Fig. 98 a description of the position to be taken in breaking up adhesions of the elbow-joint. The right arm of the masseur is placed under the patient's chin, while the hand rests on the shoulder. The patient's elbow rests on the massuer's chest and the left hand grasps the patient's wrist. In this position good control over the patient is obtained.

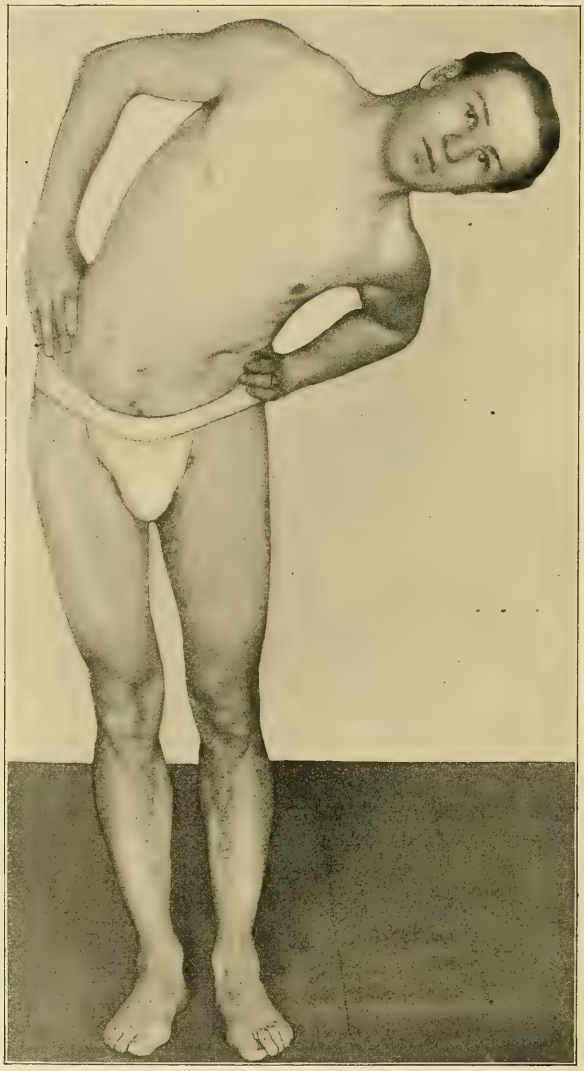
Lateral curvature of the spine may be produced in babyhood by carrying the child on one arm only, thereby making it lean to one side. Nurses are inclined to carry children on the left arm, thus producing leaning toward the right side and bending the vertebral column in the same direction. In this manner an outward curvature of the vertebral column toward the left is favored. The best mode of preventing this form of lateral curvature of the spine from originating in the manner pointed out is to have children carried alternately on the right arm and on the left, and to induce them in grasping objects to use both hands equally as far as possible. A defective mode of sitting in school often causes a certain form of lateral curvature of the spine, in which the bend in the dorsal part of the vertebral column is toward the right. While this curvature to the right of the upper part of the spine remains in its first stages, which may be recognized by the fact that the person affected is still able by the help of another person to straighten himself, Swedish movements will be found useful. By proper movements the deformity can be cured.

An important aid to the treatment of the curvature of the upper spine will be found in deep breathings affecting especially one side of the body. In this exercise the patient presses against the ribs, the hand of that side of the body toward which the convexity of the spinal curvature is pointed bends the trunk toward the same side (Fig. 99), bends the arm of the other side over the head, and breathes slowly and deeply. By so doing that half of the chest which has sunk in is expanded, and the ribs which had become flattened are gradually forced into their arched form again.

A bent carriage is one of the defects in personal appearance frequently occurring in the young, in which the vertebral column is bent

forward and in which the chest is compressed, thereby restricting respiration. To correct this defect in the carriage such exercises are successful as strengthen the muscles of the shoulders and the dorsal

FIG. 99.



Trunk-bending sideways.

muscles, and also those which expand the chest. Shoulder-movements, such as arm-spreading, arm-raising, and arm-swinging sideways and forward and backward, with arm-rotation, are to be employed.

A crooked carriage of the head is often met with both in children and in adults. It may be produced by lateral curvature of the spinal column, and also be due solely to a bad habit. In every case of such defective carriage the exercises of head-bending should be taken, and in a direction opposite to that of the abnormal crookedness.

Constipation, or habitual costiveness, and hemorrhoids, which are caused by stagnation in the hemorrhoidal veins, can be greatly relieved by exercises undertaken with energy and regularity. The exercises best used are trunk-bending, trunk-rotation, drawing in of the abdominal muscles, and, in fact, all exercises which act on the muscles of the abdomen, and which exert an alternating pressure on the organs of the abdominal cavity and move the intestines to and fro.

Swedish movements are also of value in nervous twitching movements, like those of chorea. In these cases the aim should be to regain for the will its power over the muscular system. This should be done by quiet movements well controlled, and by those exercises of the body which train it to keep its equilibrium, such as the balancing exercises. The exercises to be recommended for this purpose are:

Raising and lowering the arms (slowly);
Rotation of the arms (slowly);
Rotation of the legs (slowly);
Rotation of the hands (slowly);
Rotation of the feet (slowly);
Rotation of the fingers;
Bending of the hands;
Bending of the feet;
Bending of the knees;
Bending of the head; and, finally,
Standing on the toes.

In cases of weakness of the muscles and paralysis in different parts of the body, massage and gymnastics are very useful. For this purpose such exercises should be chosen as will put into action the portions of the body which are weak; and they should be taken at first with moderation corresponding to the condition of strength, and increased later as the strength of the patient increases. The movements to be used are:

Rotation of the arms;
Rotation of the legs;
Flexion and extension of the arms;
Flexion and extension of the legs;
Rotation of the head;
Rotation of the trunk.

In cases of writers' cramp, the muscles of the forearm which

move the hand should be exercised by quiet movements of the hand, such as—

Hand-bending;
Hand-stretching;
Hand-rotation;

and slow but vigorous closing of the fingers into the fist. Stretching the fingers, as well as spreading them apart and bringing them together, are useful movements.

Asthmatic attacks arising without traceable cause may be benefited by bodily exercises which strengthen the muscles of respiration and improve their activity. It should be remembered, however, that in all cases in which asthmatic troubles originate in affections of the heart only quiet movements are to be recommended, such as deep breathing, rotation of the head, arm-stretching, and arm-swinging.

DISINFECTION.

By W. M. L. COPLIN, M. D.

THEORY OF APPLICATION.

The gradual evolution of the science of bacteriology, and particularly the rapid strides that it has made within the last two decades, have established beyond the possibility of a doubt that many diseases are due to forms of a living contagium. In a number of diseases, such as tuberculosis, anthrax, cholera, diphtheria, typhoid fever, etc., it has been possible to isolate and successfully cultivate the organism to which the disease is attributed. As just stated, the causes of certain diseases have been satisfactorily demonstrated, but there remains a group, undoubtedly due to some living contagium, the exact character of which has so far escaped detection. To this class of diseases belong smallpox, scarlet fever, and measles—well-recognized contagious diseases, the causes of which have been eagerly sought, but have successfully evaded the investigator. Upon this group science is gradually making invasions, and it may be confidently expected that before many years we shall be as familiar with the etiologic factors as we are at present with those of diphtheria and erysipelas. It can be clearly demonstrated to the open-minded that the diseases of uncertain origin, or, as is usually stated, uncertain bacteriology, are closely related to those whose causes have been fully worked out. One of the strongest arguments—indeed, it may be said a conclusive argument—going to establish the correctness of this statement is the well-recognized truth that diseases belonging to the group to which reference is now being made may be suppressed by the application of methods known to be efficient against diseases the bacteriology of which is thoroughly established.

While bacteriology has demonstrated that certain morbid conditions are dependent upon and occur only in the presence of a given form of vegetable life, extended research has shown that not a few diseases result from the activity, or are constantly associated with the presence, of unicellular elements, or even more complicated forms, belonging to the lower types of animal life. The morbid processes that depend upon the presence of amœbæ and coccidia, or other parasite admittedly of animal origin, must be classed with diseases

of this kind. As extended information may bring to light other, and at present unknown, forms of animal life capable of producing disease, it seems appropriate to assume that the principles of disinfection should be extended to this group. It would lead afield to enter into the purely theoretical discussion as to whether diseases of parasitic origin are infective in the same sense as the bacterial diseases. The important practical point is that the same preventive measures are efficient, and after all that is the essential question to be settled.

In a disease arising from some cause belonging to either of the foregoing—(1) diseases the bacteriology of which seems settled, (2) diseases of uncertain bacteriology, (3) certain processes depending upon animal parasites—it will be evident that its successful suppression must depend upon our ability to destroy or render inactive its cause, and the recognition of the fact that the cause may be destroyed by appropriate means properly directed.

A brief review of the resources at our disposal shows that, in the suppression of contagious diseases, quarantine, depopulation, isolation, segregation, and disinfection constitute the methods applicable under nearly all circumstances. Of the various means needed for the throttling of disease, disinfection is probably the most important. As usually applied, disinfection is the destruction of infective material. This infective material may be for our purpose regarded as a low form of animal or vegetable life, principally the latter. It is, of course, to be recognized that all vegetable or animal life belonging to the groups indicated is not infective—in other words, is not endowed with the power of producing disease; but, as in many diseases we are unfamiliar with the exact cause, it becomes necessary to treat with suspicion every particle of life contained in infective material. Hence disinfection implies not only the destruction of bodies capable of inducing infection, but also the extermination of associated non-infective forms of bacteria. The term disinfection has therefore become synonymous with sterilization, and all of the tests applicable are based upon the belief that disinfection insures sterilization. The bodies and means used to secure disinfection are called disinfectants; and as disinfection has been described to be, at least in part, the process of destroying germs, it will be observed that the disinfectant becomes to all intents and purposes a germicide. Closely allied to the germicides are the antiseptics; really an antiseptic is an agent which inhibits, or arrests, or retards the growth of the germ without of necessity destroying it. Antiseptics are not necessarily disinfectants; but, on the other hand, disinfectants are of necessity antiseptic; even a weak solution of the disinfectant may act as an antiseptic, while the reverse is by no means true. Thus, cold is an antiseptic in that it retards the growth of bacteria, but so

far the lowest obtainable temperatures have not been found trustworthy for germicidal purposes. Agents used for the destruction of odors are called deodorants or deodorizers.[1] A disinfectant may or may not be a deodorant, and a deodorant is not necessarily a disinfectant.

DISINFECTANTS.

Agents used for securing disinfection may be either chemical or physical, and to the latter, for the most part, belong the bodies operative in the natural disinfection or destruction of infective matters.

Disinfection by Means of Chemicals.—Simply to enumerate the chemical germicides that from time to time have been advocated would occupy more space than the importance of many would justify. Applicability, cost, and efficiency have, by a process of exclusion, weeded out the least efficient, excluded the unavailable, and left a few upon which we may thoroughly depend. The ideal chemical disinfectant has not been discovered. It should fulfil the following requirements:

It must be stable and must not lose its germicidal power when brought in contact with materials to be disinfected. It must be destructive to bacteria and the lower forms of animal life. It should be cheap, easily obtained, and readily applied. For special purposes it is necessary to possess a disinfectant that is not injurious to the tissues of the living body in the condition in which it is used. For other purposes agents are needed that do not injure the materials with which the infective bodies may be associated, as carpets, upholstery, clothing, etc. It is unnecessary to say that an agent possessing all the requirements just indicated is not available. Had we been able to obtain such a body many of the disinfectants that must be considered could be discarded. Unfortunately, a disinfectant applicable under all conditions and at all times has not as yet been found, and for this reason it is necessary to possess a number of agents. From these selection for special purposes can be made, as will be advised when considering practical disinfection. In no department of public sanitation are the intelligent choice of procedure and detailed application of a method more important. Conditions determine the agent to be selected as well as the proper method of application. The applicability of different disinfectants to special purposes will be in place when considering the disinfection of rooms, excreta,

[1] The individual who applies the agent is properly called the deodorizer, but in many articles consulted it is evident that writers use the same word for the agent.

etc., but at this point it is permissible to mention certain general directions of importance.

In the process of disinfection it is to be remembered that certain organisms possess spores, and that these bodies are far more resistant than the fully developed germ, and that therefore spore-bearing bacteria must be dealt with in a more energetic manner than the non-spore-bearing forms. The question of chemical compatibility must also be considered. It would be clearly an error of judgment to use corrosive sublimate for the disinfection of highly albuminous compounds or expect it to be efficient in the presence of alkalies. In the presence of either of these conditions, should corrosive sublimate be the only disinfectant available, it is evident that the material must receive some treatment to prepare it for the disinfectant, or the latter must be presented in a form in which its efficiency will be maintained. It is just such points that always merit special consideration, and hence the routine use of an agent, irrespective of its real applicability, must result in many failures. To many, accentuation of this apparently self-evident fact may seem unnecessary, but when an official connected with a state service attempts to disinfect latticed cow-sheds with sulphurous acid gas specific directions for avoiding such blunders become permissible.

Whatever disinfectant is selected, it should be remembered that its addition to a fluid to be disinfected gives rise to more or less dilution; thus a pint of a 5 per cent. solution of carbolic acid added to a pint of urine or fæces results in a quart of mixture containing, however, only 2.5 per cent. of the disinfectant. The same principle must be borne in mind when volatile or gaseous disinfectants are used.

Chemical Disinfectants.

Corrosive Sublimate.—The bichloride of mercury (hydrargyri chloridum corrosivum) is one of the most efficient germicides that we possess. It is used for disinfecting purposes in the form of an aqueous solution, the strength of which may be from 1 part in 10,000 parts to 1 part in 125 parts. The last-named strength is too dilute for general purposes, while solutions as strong as 1 in 125 cannot be applied to living tissues. The solution in common use is of a strength of 1 part of the corrosive sublimate to 1000 parts of water. Its disinfecting properties and stability are improved by the presence of acids, particularly hydrochloric acid, although vegetable acids, such as tartaric acid, may be used to advantage. The hydrochloric or tartaric acid necessary to prevent decomposition must be at least five times the quantity of mercury present in the solution. Corrosive sublimate is conveniently handled and the solutions readily prepared by keeping the salt in the form of a saturated alcoholic solution or,

what is better, a solution of known strength, namely, a drachm of corrosive sublimate to an ounce of alcohol, which may be strongly colored by one of the anilin dyes. The stability of the alcoholic solution and of dilutions made from it is increased by keeping in the bottle an excess of ammonium chloride or sodium chloride; when one of these salts is used, as advised, the sediment in the alcoholic solution should be disseminated by shaking before measuring out the requisite quantity. A teaspoonful of this solution added to a pint of water containing a teaspoonful of salt makes a solution the strength of which is approximately 1 : 1000, and containing the requisite quantity of common salt to prevent decomposition of the mercurial. Tablets are on the market containing various strengths of the corrosive sublimate, and adapted to the addition to known quantities of water, and when dissolved afford solutions containing a definite amount of the disinfectant. The water used for the preparation of the solution should be pure and, above all, free from alkalies and sulphur compounds capable of decomposing the mercuric salt.

Although corrosive sublimate is one of the most reliable disinfectants when applied under selected conditions, it is open to objections. In the first place, it is one of the most poisonous bodies that could be suggested for the purpose; aqueous solutions are without either odor or color, and hence the danger of its being accidentally swallowed is very great. This danger may be lessened, to a certain extent at least, by coloring the solution, for which purpose anilin dyes are frequently used. A few drops of an alcoholic solution of eosin or fuchsin suffice to color a gallon or more of the corrosive sublimate solution. The dangers from the local use of the agent cannot be overlooked. Solutions of corrosive sublimate to be applied to the unbroken skin should not exceed 1 part of the salt to 500 parts of water. Many persons cannot bear without injury solutions stronger than 1 : 1000; the delicate skins of women and particularly children may be irritated or positively inflamed even by this dilute solution. The mucous membranes are still more susceptible to the irritant action of mercury, and rarely bear the repeated applications of solutions the strength of which exceeds 1 : 5000. Absorption of the salt through the skin, when presented in aqueous solutions of the strengths advised, is not believed to occur; on the mucosæ this is different, and unfortunately susceptibility to the action of the salt is sometimes very great. Absorption from the serous surfaces is also possible. It would appear that the dangers from absorption are greater in the presence of albumin, and that the albuminate formed on mucous and serous surfaces is more dangerous than the bichloride itself; data establishing the correctness or incorrectness of this view are not at hand. In wounds, solutions of corrosive sublimate, once so popular, are now known to

induce destruction of cells and impede repair, if not actually favoring infection by lowering resistance. Solutions stronger than 1 : 1000 are rarely used on raw surfaces; the use of tartaric acid or normal salt solution to prevent the formation of an albuminate is commended. The danger of absorption from the skin is not deserving of consideration except in very rare cases. The dangers from volatilization have certainly been exaggerated. Sjoqvist has exploded the theory that there is danger to the health of sanitary employés during disinfection of walls, floors, etc., by corrosive sublimate, or to individuals living in rooms that have been subjected to such disinfection.

An objection to the bichloride, which it shares in common with a number of the best disinfectants, is its fixing property. In the presence of bodies containing albumin, blood pigment, and other proteids these are so fixed as to render their subsequent solution difficult if not impossible. For this reason the application of corrosive sublimate to bed-linen and garments soiled by blood, fæces, or other albumin-containing bodies, is to be avoided. Another important objection to corrosive sublimate is the fact that it is destructive to all of the common metals with which it comes in contact, and that in its attack upon the metal it is itself decomposed. For this reason solutions must be kept in glass, earthenware or, in their absence, wooden containers. Wood is not advised, as it becomes rapidly impregnated with the salt and cannot be cleaned beyond the possibility of danger.

Biniodide of mercury (hydrargyri iodidum rubrum) is usually regarded as a more active disinfectant than the bichloride. It is less influenced by the presence of albumin, and therefore its activity persists under conditions which would render corrosive sublimate inefficient. It may be used in practically the same strengths, although it is usually considered efficient in a solution possessing one-half the strength of trustworthy bichloride solutions; while, as already stated, the usual strength of bichloride used is 1 : 1000, the biniodide may be employed in a strength of 1 : 2000. The salt is insoluble in water except in the presence of iodide of potassium or chloride of sodium; the former is usually employed; only a small amount is necessary—more than twice the quantity of the mercurial. That is to say, for every grain of the biniodide of mercury at least two grains of the iodide of potassium will be needed.

Iodine trichloride is one of the most reliable disinfectants known. Its bactericidal power approaches corrosive sublimate and it is superior to carbolic acid. The agent is efficient in the presence of highly albuminous compounds. A 1 per cent. solution destroys anthrax spores in less than five minutes. It is claimed that a 1 : 1000 aqueous

solution is the most trustworthy agent that we possess for the disinfection of the hands. For sanitary disinfection, as for stools, sputum, etc., it is recommended that a 5 per cent. solution should be used; for most purposes this solution can be diluted one-half, or, where the material to be treated is fluid, disinfection will follow the addition of an equal quantity of the 5 per cent. solution of iodine trichloride.

Chloride of lime (hypochlorite of lime, chlorinated lime, calx chlorata) is an efficient disinfectant provided the agent is freshly prepared and contains the requisite amount of available chlorine, which should be 25 per cent. The Pharmacopœia demands a strength of at least 35 per cent. This is rarely present in the commercial article. The ineffectiveness of this most excellent disinfectant in many experiments must be attributed to the deficiency in chlorine in the samples examined. This deficiency results from one of two causes: (1) The article as placed on the market is not up to the standard. (2) The container is not trustworthy. The latter defect is apparently the more common. The metal containers frequently leak or are poorly constructed, and the paper boxes are susceptible to moisture and are often broken during transportation. A reliable chemist informs the writer that paper boxes, thick and solid, coated on the interior with rosin and carefully sealed, are deserving of more confidence than the metallic containers usually commended. The humidity or aridity of the air should always be considered, and pharmacists should be advised of the necessity of procuring the chloride of lime in containers that can be trusted.

The method of application depends upon the character of the material to be disinfected and the presence or absence of spores. In fluids such as excreta the dry powder can be added in sufficient quantity (by weight) to make a 4 per cent. solution; if spore-bearing bacteria are to be destroyed, the strength of the solution should be not less than 10 per cent. For routine disinfection four ounces of the chloride of lime should be added to one gallon of water; such a mixture contains about 4 per cent. of the lime.

A much more elegant although somewhat more expensive disinfectant is the solution of chlorinated soda (liquor sodiæ chloratæ, Labarraque's solution). For use, one part of Labarraque's solution is added to four or five parts of water.

The efficiency of the foregoing solutions depends largely upon the amount of chlorine that they contain. The lime probably aids in retaining the chlorine and possesses feeble germicidal powers. The solutions should be prepared in crockeryware or glass vessels, as the chlorine attacks nearly all metals. Such chlorine and lime mixtures, because of their activity as deodorants, are especially applicable for the disinfection of matters giving off disagreeable odors.

Calcium Hydroxide.—Lime may be applied in a number of ways for the purpose of disinfection. The recently burned quicklime, or caustic lime (calcium oxide), should be used when possible. This may be crushed and sprinkled over the material that it is desired to disinfect. It will, of course, destroy nearly all organic substances with which it comes in contact. Moisture is absolutely necessary to its action, and therefore dry bodies should be moistened before the application of the disinfectant, or it may be used in water. Lime is commonly used in the form of "milk of lime." To be efficient it must be freshly prepared from active quicklime. The lime to be used should be selected with care, avoiding old, more or less slacked, or "dead-lime." The lumps of unslacked lime should be placed in a crockeryware or wooden receptacle, preferably the former; over the lime an equal volume of water is poured. As soon as slacking is completed (requiring from one-half to one hour) water is added, with continuous stirring, until the density of the solution is that of a very thick cream. Where an accurate and constant mixture is required, which is advised, the lime is slacked as just directed, and then mixed with water in the proportion of one part of the lime to four parts of water; such a solution is, approximately, 20 per cent. calcium hydroxide. The mixture so prepared is useful only in the fresh state, although it may be kept for a few days in stoppered containers; it possesses very slight penetration, and must, therefore, be thoroughly mixed and brought in intimate contact with the material to be disinfected. It will be observed that the solution as recommended is practically the same as that known as whitewash. The agent is trustworthy for the destruction of non-spore-bearing bacteria, but is inefficient against the tubercle bacillus and many spore-bearing organisms. For the disinfection of surfaces the 20 per cent. solution is applied with a brush. Finely divided solid matter must be intimately mixed with the preparation. In the disinfection of liquids the lime solution should exceed in bulk the material treated. If after several hours the mixture (material to be disinfected plus the lime) is not strongly alkaline, no dependence can be placed on the attempt at disinfection.

Carbolic acid (acidum carbolicum) may be purchased in the open market in a number of forms. The commercial acid is an extremely crude product that, in addition to the carbolic acid present, contains a number of impurities, some of which are not disadvantageous. For disinfection on a large scale the use of the crude material is permissible. The different forms of the crude acid vary in solubility and in their disinfecting power, so that health officers, contemplating the use of carbolic acid on a large scale, should purchase by sample, the activity and solubility of which have been previously determined by

experiment. As a rule, the purer grades of carbolic acid are less soluble in water than the crude. A saturated solution of the pure drug is approximately 5 per cent. Solution in water to saturation requires thorough agitation for some time. If for any reason solutions of greater strength are needed, it becomes absolutely necessary to add some agent that increases the solubility of the carbolic acid; for this purpose glycerin is commonly used. A 10 per cent. solution of carbolic acid may readily be prepared by using ten parts of the agent mixed with ten parts of glycerin, and adding to the resulting mixture eighty parts of water. Glycerin slightly reduces the disinfecting power of carbolic acid, and becomes objectionable when (by its addition) the volume of water present in the mixture falls below 80 per cent. The presence of soap increases the solubility of the acid; Freund recommends green or potash soap. Six per cent. of the soap will permit the dissolving of carbolic acid to a strength of 12 per cent.

Carbolic acid is very generally used for disinfection, but is unreliable in the presence of spore-bearing bacteria. It possesses the advantage of stability, being little influenced by materials with which it comes in contact. In the presence of albumin the disinfecting power is but slightly diminished. The bactericidal power of carbolic acid solutions may be augmented by the addition of one of the following agents: hydrochloric acid (1 per cent.), sulphuric acid (5 per cent.), sodium chloride (5 per cent.), or soap as already directed. The activity of carbolic solutions is greatly increased by raising the temperature to or near 50° C. In order to insure disinfection, solutions weaker than 5 per cent. should not be used, and stronger solutions are injurious to the skin.

The objections to the use of carbolic acid as a disinfectant are principally its uncertain disinfecting power, its poor penetration, its disagreeable odor, and its intense toxicity. In addition to the fact that it is poisonous, it must be borne in mind that idiosyncrasy to it, indeed to the odor of carbolic acid, is sometimes remarkable. Individuals may be so susceptible that the presence of the small amount of carbolic acid which may be diffused in the atmosphere may give rise to hæmaturia and other toxic phenomena.

Cresol is a product obtained by the fractional distillation of crude carbolic acid. The material is placed upon the market in three forms—orthocresol, metacresol, and paracresol. Mixtures of the three cresols are dispensed as tricresol. Mixtures of the cresols can be prepared which, when added to water, form clear solutions; on the other hand, more or less insoluble compounds occur which, when mixed with water in the presence of soap, form emulsions. The tricresol available commercially varies slightly in the proportion of each of

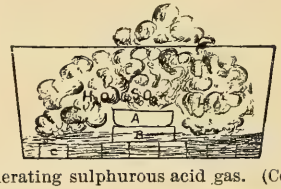
the cresols present. It is used as a disinfectant in 2 to 2.5 per cent. aqueous solutions, and is said to possess at least twice the disinfecting power of carbolic acid.

Lysol contains, approximately, 50 per cent. of cresol and a varying amount of neutral potash soap. Its action is very much like that of carbolic acid; it is, however, less poisonous and more actively disinfectant. A 3 per cent. solution of lysol is said to be as efficient as a 5 per cent. solution of carbolic acid. This is due, partly at least, to the increased penetration possessed by the mixture, a result to be attributed to the presence of the soap. Its disinfecting power is remarkably increased by gently warming, as its activity at 22° C. is doubled by raising the temperature to 60° C. One of the objections to lysol is that it makes everything with which it comes in contact extremely slippery. This is due to the soap which it contains. It has the advantage, however, of being a valuable cleansing agent; as a disinfectant it is in every respect superior to carbolic acid.

Creolin is an emulsion of only partially soluble cresols, and like lysol is prepared by the addition of soap. Of the many forms of creolin in the market, it is said that only Pearson's creolin is to be relied upon. The best creolins contain only 10 to 20 per cent. of cresol, and are therefore inferior to lysol. Sporeless anthrax bacilli are destroyed by 10 per cent. solution of creolin in twenty-four hours; in the spore-form 50 per cent. fails to sterilize the medium in the same length of time. It will therefore be observed that for spore-bearing bacteria creolin is a totally unreliable compound. The great advantage claimed for cresols, tricresol, creolin, and lysol, is the fact that they can be mixed with water and with albuminous compounds without the danger of decomposition, retaining their disinfecting power.

Sulphur Dioxide.—This agent, at one time extensively employed for disinfecting purposes, has been largely superseded by formal-

Fig. 100.



Simple contrivance for generating sulphurous acid gas. (Coplin and Bevan.) *A*, shallow iron pan for the reception of the sulphur. *B*, bricks upon which the pan rests, supporting it above the water. *C*, hot bricks or stones thrown into the water at the time of starting the combustion of the sulphur; the heat causes the evolution of steam. The outside vessel (shown in outline only) may be a washtub, iron kettle, or a very large bucket.

dehyde. The sulphurous acid gas is most conveniently generated by burning sulphur in the room. Four pounds of sulphur should be

burned for each 1000 cubic feet of air-space. As sulphur sometimes splutters while burning, it is necessary to guard against danger from fire, in the following manner: A washtub, or similar vessel, is placed near the center of the room and sufficient water poured in to cover half of three bricks lying on the broad side. The bricks are so arranged as to support a skillet or pot which receives the sulphur. The sulphur is ignited by pouring over it alcohol, which is then set afire. In order to render the production of gas more abundant and more rapid it may be necessary in large rooms, where the space exceeds 10,000 cubic feet, to arrange two or three tubs, so that the gas may be simultaneously generated from a number of points. As sulphur dioxide is most active in the presence of moisture, it is best to moisten the walls or to suspend in the room paper or sheets saturated with water. The sulphur may be obtained in the form of candles, and pyramidal blocks containing a wick that is easily ignited. This must, however, be arranged as already advised for the powder or lump sulphur. The most convenient, but very much more expensive, method consists in the use of compressed dioxide obtained in metallic containers. These are sealed by means of a small lead pipe fused at its end. The gas is liberated by cutting off the tip of the lead pipe and laying the container in a basin from which the gas is given off to the surrounding atmosphere. For larger spaces the gas is supplied in cylinders controlled by valves that may be simply opened in the room or the gas may be conducted into the room through the key-hole by means of a tube connected with the container. In order that the disinfection be at all satisfactory it is necessary that the air in the room contain at least four volumes per cent. and that this degree of saturation be maintained for at least twelve hours, or better twenty-four hours. In order to maintain this percentage it is necessary to prevent egress of the gas by calking or in other ways closing all openings. (See Rooms.) The requisite amount of moisture in the atmosphere may be supplied, as already directed, by moistening the walls or suspending in the room sheets saturated with water. In large disinfecting plants or where the gas is generated on a large scale, as in municipal and quarantine disinfection, special arrangements are made for the introduction of steam usually through a small pipe or hose brought from a boiler.

The objections to sulphurous acid gas are its unreliability, especially in the presence of spore-bearing bacteria, the necessity for moisture which may of itself be objectionable, and the bleaching power which it invariably manifests. Moistened fabrics, wall paper, curtains, and other articles containing colors, are usually ruined by exposure to the gas, and many paints are injured by its action. It

is inexpensive, easily applied, and, as sulphur can nearly always be obtained, is available when more reliable agents are not at hand.

Formaldehyde.—The most recent addition to the list of agents for disinfection is formaldehyde. Formaldehyde is a product resulting from the incomplete oxidation of methylic alcohol, and has the formula of CH_2O. It possesses advantages eminently its own, in that it may be used in the form of a solution or as a gas. Formalin is a proprietary article composed of 40 per cent. aqueous solution of formaldehyde. Solutions of the same strength are placed upon the market under the names formic aldehyde, formaldehyde, formolose, formal, and formol. The agent may be used for disinfecting purposes in the form of an aqueous solution, also as a moist vapor, and in the dry or pure gaseous state. In addition to its reliability as a disinfectant formaldehyde is an efficient deodorant. A strength of from 1 to 5 per cent. aqueous solution of formaldehyde may be depended upon for destroying sporeless bacteria, and may be used for disinfecting excreta and discharges, and surfaces such as floors and woodwork of all kinds.

The pure formaldehyde gas for disinfecting purposes is generated from three sources: (1) by the combustion of wood alcohol; (2) it may be disengaged from its aqueous solution, formalin, formolose, etc.; or (3) the gas may be produced by the vaporization of paraform.

1. With regard to the first method, the production of formaldehyde by the combustion of methylic alcohol, the writer is convinced of its uncertainty. The lamps for generating the gas at present upon the market fail to assure that a definite quantity of gas will be produced in a given time, and hence, in the writer's estimation, they are not to be recommended. Other methods of generating the gas, about to be described, are reasonably uniform in their results, much more easily applied, and free from the dangers of fire and the uncertainty attending attempts at the production of sufficient formaldehyde by the incomplete combustion of wood alcohol.

2. The liberation of formaldehyde from its aqueous solution:

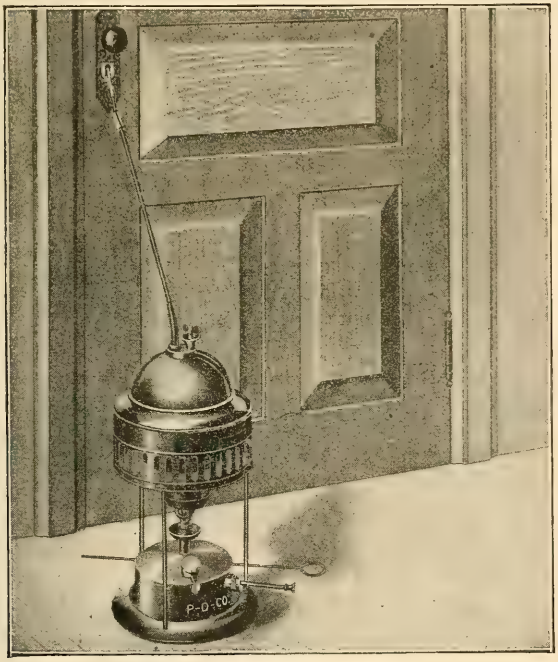
a. The first and probably the most convenient method, although undoubtedly not the most accurate and possibly not the most satisfactory or efficient, is the liberation of gas from sprinkled sheets or other suitable fabrics. It is stated[1] that an ordinary sheet will imbibe from 150 to 200 c.c. of formalin without dripping, and, presented in this form, the quantity is sufficient to disinfect 500 cubic feet of space. The sheets may be suspended in the room and moistened by spraying, and this is the best method; or they may be loosely wrung

[1] *Journal of American Medical Association*, April 23, 1898.

out of the formalin and thrown over chairs and other furniture, and so arranged as to expose to the air the entire surface of the saturated fabric. It is claimed that superficial disinfection is assured by this method, and that the penetration is equal if not superior to that obtained by the use of special forms of apparatus presently to be described.

b. The gas may be liberated by heat from the aqueous solution. Of the various forms of apparatus for the generation of formaldehyde gas by heating formalin, that shown in Fig. 101 is particularly

FIG. 101.

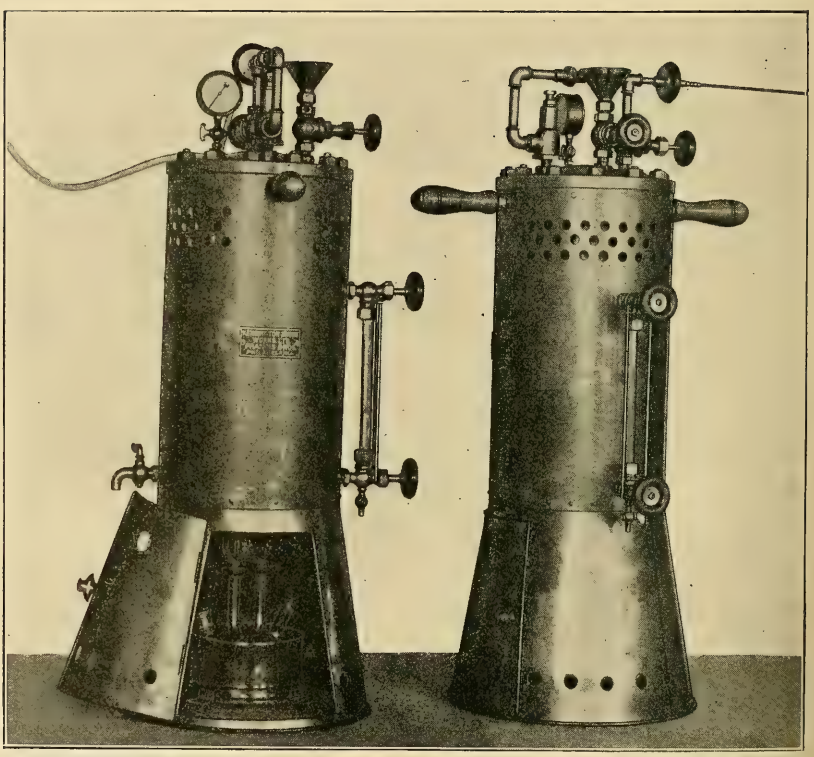


Novy's formaldehyde generator.

to be recommended. The Novy apparatus consists of a seamless copper retort in which the aqueous solution is placed. From this retort a flexible rubber tube connected with a metallic nozzle is so constructed as to be readily passed through the key-hole into the room to be disinfected. A further requisite is a lamp containing either alcohol or kerosene, and capable of affording sufficient heat to volatilize the formalin in the retort. Since the experiments of Novy exploded the theory that polymerization of the formalin rendered the method of little value, a number of manufacturers have placed on the market more or less accurate reproductions of the original apparatus.

Another apparatus especially useful is a form of the autoclave. In this instrument the danger of polymerization is reduced to a minimum by the moderate superheating of formalin in the presence of a body that retains the water and drives off the dissolved gas. The agents commonly used to secure this result are calcium chloride and sodium nitrate, either of which should be added to the formaldehyde solution in the proportion of 10 to 30 per cent. The autoclave contain-

FIG. 102.



Kinyoun-Francis autoclave for the liberation of formaldehyde from formalin in solutions containing calcium chloride. Two views of the apparatus are shown. The tubes on the right and left passing to the margins of the figure conduct the formaldehyde into the room to be disinfected.

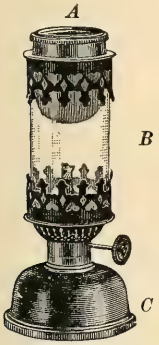
ing the chloride of calcium solution and formalin is slowly heated until the air has been discharged, when the valves are closed and the pressure permitted to rise to between three and four atmospheres. As soon as this pressure is reached the nozzle is passed through the key-hole, or other suitable opening, into the room to be disinfected, and the vaporization is continued until the requisite amount of formaldehyde has been driven into the room.

The efficiency of the methods just advised depends upon the

attainable concentration of the gas by the relatively rapid delivery in the room. The room should be rendered as nearly free from draughts as possible (see Rooms, page 572). The amount of the formaldehyde (aqueous solution) necessary depends upon the character of the organism to be destroyed; for non-spore-bearing bacteria one pint (500 c.c.) of the 40 per cent. solution will be sufficient for 1000 cubic feet of space; for the destruction of spore-bearing organisms the quantity should be doubled.

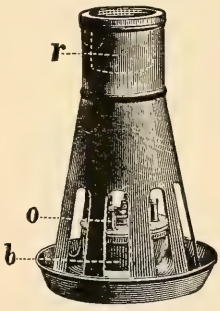
c. Under the name polymerized formaldehyde, paraform, paraformaldehyde, and trioxymethylene,[1] there has been introduced, as its name indicates, a polymerized formaldehyde from which the gas may be liberated. The agent is commercially available in the form of tablets each weighing one gramme (15.4 grains). For the satisfactory vaporization of polymerized formaldehyde tablets a special form of lamp is necessary. This lamp is constructed on the principle shown in Figs. 103 and 104, the requisite being a slight admixture of the

FIG. 103.



Lamp for volatilization of formaldehyde from paraform. *A*, receptacle for the paraform tablets. This size holds but 50 grammes. *B*, chimney. *C*, reservoir for alcohol.

FIG. 104.



Larger size formalin disinfector for the volatilization of formaldehyde from paraform. *r*, receptacle for the paraform tablets. *b*, reservoir for alcohol; filled through tubulature at *O*.

heated paraform with the products of combustion resulting from burning alcohol. It is necessary to use at least two grammes of the agent to one cubic meter of air space—that is, approximately, 60 grammes (nearly 2 ounces) to every 1000 cubic feet. In the presence of spore-bearing bacteria the quantity of paraform should be doubled. With this apparatus the gas is, of course, liberated in the room which has been previously prepared as will be directed. (See Rooms, p. 572.)

General Remarks on Formaldehyde as a Disinfectant.—Taken in a general way formaldehyde is the best agent at present available for disinfection. Its advantages are the simplicity of application, the

[1] Also spelled trioxymethylin.

fact that it is a reliable disinfectant, and, in the concentrated form, in the absence of moisture, possesses fair penetrating power. In the presence of very much moisture its penetration is limited. One of its advantages is the fact that the gas does not perceptibly injure the most delicate fabric. The only exception to this statement is that it changes the color of certain anilin dyes, particularly if the fabric is moist, but as dyes of the kind affected are rarely used this objection can be overlooked. With regard to penetration the following statements may be made:

In the concentration proposed the gas is an efficient surface disinfectant when applied in a tightly closed chamber and permitted to act for twelve hours, or better twenty-four to thirty-six hours. In a .comparatively small space and in a very concentrated form (equivalent to one liter (about 1 quart) of formalin in 1000 cubic feet of space) penetration is very much better and may be relied upon for the disinfection of clothing, and possibly of bodies as thick as small pillows and thin mattresses. The efficiency of the agent depends upon its concentration rather than the length of exposure. An important observation is the influence of heat: in warm rooms (at or near 37° C.) the effectiveness of the agent is wonderfully increased, and therefore all rooms to be disinfected should be thoroughly warmed preliminary to the application of the gas.

After the articles have been exposed to the action of formalin for the requisite length of time the penetrating and persistent odor, which is usually objected to, and is intensely irritating, will readily disappear in the presence of ventilation, exposure of the articles to the open air, or may be more rapidly destroyed by the use of ammonia. The amount of ammonia necessary to neutralize the formaldehyde is 1.25 liters (1.26 quarts) of concentrated ammonia water for each liter of formalin. If tablets have been used, ammonia should be applied in the proportion of 1 liter to 150 tablets.[1] The ammonia should not be liberated in the room until the formaldehyde has been permitted to act sufficiently long to assure disinfection.

It is usually maintained that formalin is innocuous to animals, and that it is not an insecticide. This statement is probably true when the atmosphere is not heavily charged with the vapor. The experiments of Harrington and others, as well as the writer's personal observation, lead to the belief that efficient disinfection is likely to prove fatal to animals as well as to bacteria, and that the agent is an insecticide as well. Like corrosive sublimate, formaldehyde is a fixative of a high order, and renders stains containing albumin almost insoluble.

[1] Treasury Department Circular, No. 124.

Physical Agents as Disinfectants.

The only agents meriting special consideration in this connection are: light, abundant aëration, cold, and heat.

Light.—Direct sunlight is undoubtedly germicidal, as has been proved by numerous experiments. Many pathogenic bacteria succumb to its action in varying lengths of time. Thus it has been demonstrated that the Bacillus typhosus, Bacillus diphtheriæ, spirillum of Asiatic cholera, the Bacillus tuberculosis, and numerous cocci may be destroyed by exposure to sunlight or even to diffused light.

Abundant aeration is useful in that it desiccates the bacteria, and, by depriving them of moisture, lessens the probability of pullulation. The rapidity with which desiccation destroys or renders inert pathogenic bacteria is not the same for any two organisms, and often differs for the same organism under different conditions. That moisture is requisite for the preservation of bacterial life has been repeatedly demonstrated in laboratory experiments.

It may be said with regard to light and aëration that practically they are never used with the idea of disinfection, as we at present contemplate the term. They are, however, important adjuvants to purification of areas likely to become infected, and by proper use may be made to prevent the accumulation of infective material. Their application is general rather than special, but they are undoubtedly efficient aids against such eminently infective diseases as diphtheria, tuberculosis, and cholera.

Cold.—The lowest attainable temperatures have proved inefficient as germicides, and, therefore, cold is not to be recommended as a disinfectant. The one disease in which cold seems to be an efficient agent is yellow fever; so far, this well-known fact has not been successfully applied as a sanitary measure.

Heat.—Of all the agents proposed and applied for disinfection, heat merits a preeminent position. If properly applied, it affords the only absolutely certain method of disinfection.

Fig. 105.

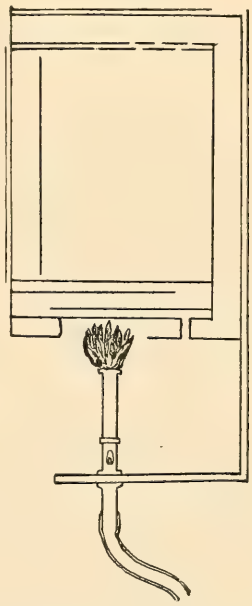


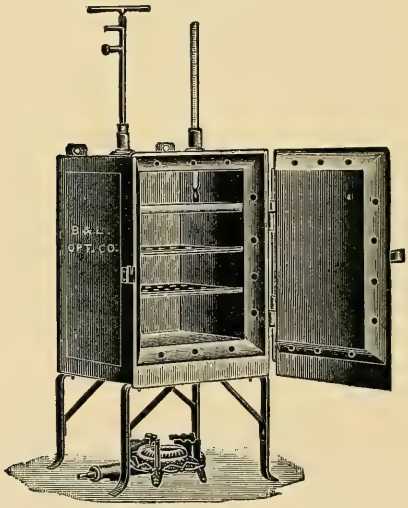
Diagram illustrating principle of construction of hot-air sterilizer. (Coplin and Bevan.) The chamber in which disinfection is accomplished is surrounded on all sides by a jacket of air that is heated before the inner space. No matter what size the apparatus may be, this principle of construction is necessary to efficiency.

Fire.—The destruction by flame of material supposed to carry

infection is often utilized; articles possessing little or no value may be so destroyed; in the same way discharges, dressings, etc., may be rendered bland. In the cases of lower animals suffering from or dead of infective diseases, incineration of the bodies under suitable conditions is probably the most certain way to assure disinfection. Special apparatus has been devised for the burning of garbage and refuse material, and this may be applied also for disinfection. As a rule, however, the application of fire is restricted to matters that are easily destroyed and without value.

Dry Heat.—Dry heat is applied for the disinfection of materials that would be injured by steam. It is, however, of the various forms

FIG. 106.



Hot-air sterilizer used for the disinfection of mail, glassware, instruments, etc.

in which heat is used, the least efficient and most difficult to apply. Its efficiency is largely dependent upon the character of the organisms to be destroyed, and it is least active upon spore-bearing bacteria. To insure sterilization a minimum temperature of 130° C., with a time exposure of at least half an hour, should be employed. At this temperature many bodies are destroyed, and hence the method is rarely applicable.

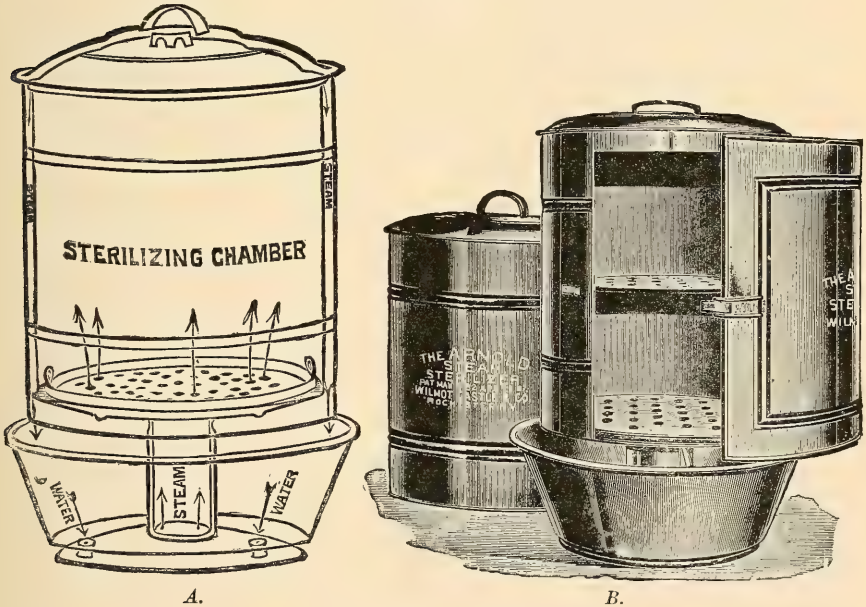
In the construction of appliances for disinfection by dry heat the principle of the ordinary baking-oven in the kitchen stove is adopted. Hot-air sterilizers consist of a central space in which is placed the article to be disinfected; around this chamber should be a hot-air jacket that can be uniformly heated to the temperature desired.

The source of heat is usually a high-grade radial or rose gas-burner of the Bunsen type. The principle of construction is illustrated in

Fig. 105, and the usual form of a hot-air oven is shown in Fig. 106. At one time sterilization of instruments by heat was commended, but the influence of the requisite temperature on the temper of steel has led to its being abandoned. It is still used on a small scale for the disinfection of mail in hospitals for contagious diseases.

Moist Heat.—*Boiling.*—For the disinfection of articles not injured by boiling and of a size rendering the method applicable there is no means more efficient. It is especially to be recommended for soiled bed-linen and wearing-apparel, and has been generally adopted for the disinfection of surgical instruments. In order to secure disinfection by boiling it is only necessary to insure penetration. Penetration is facilitated and the destruction of germs favored by the introduction of a permanent alkali, such as lye or washing-soda; the latter is used in a strength of 1 or 2 per cent., which is obtained, approximately, by the addition of a heaping teaspoonful of the salt to each quart of water.

Fig. 107.



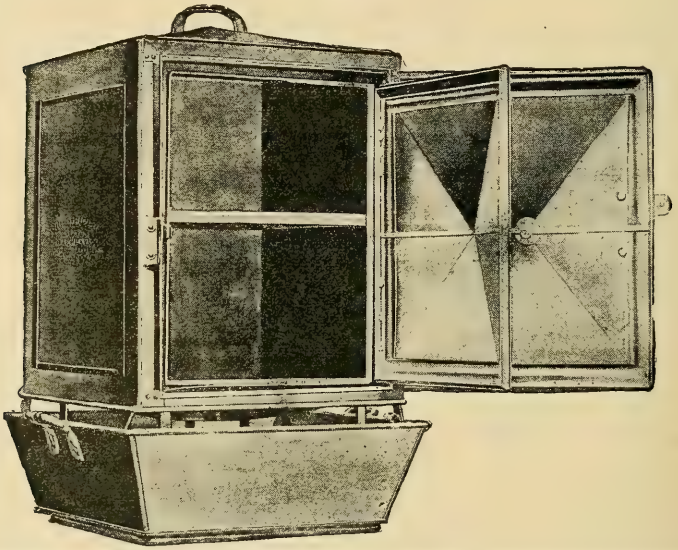
A. *B.*

Arnold steam sterilizer. A, diagram illustrating principle of construction. B, cylindric form, with door on side. These are also made open at the top, and are especially to be commended for the sterilization of milk, artificial foods for infants, surgical dressings, instruments, etc.

Saturated streaming, or *live, steam* is, if properly applied, quite as efficient an agent for disinfection as boiling water. In addition, it can be utilized under conditions which preclude boiling. In order to render it efficient the article to be disinfected must be placed directly in the flowing steam, which must be supplied in a quantity

sufficient to maintain a temperature approximating 100° C. (212° F.). For disinfecting on a small scale nothing has been found superior to the Arnold steam sterilizer (Figs. 107 and 108), which has supplanted nearly all the older steam appliances of this kind. The length of time necessary for disinfection by steam depends upon the penetrability of the article to be disinfected. Articles loosely placed and accessible on all sides, such as instruments, may be disinfected in from fifteen to twenty minutes, or, possibly better, a half hour. Materials requiring considerable time for penetration will, of course, demand a longer exposure.

Fig. 108.

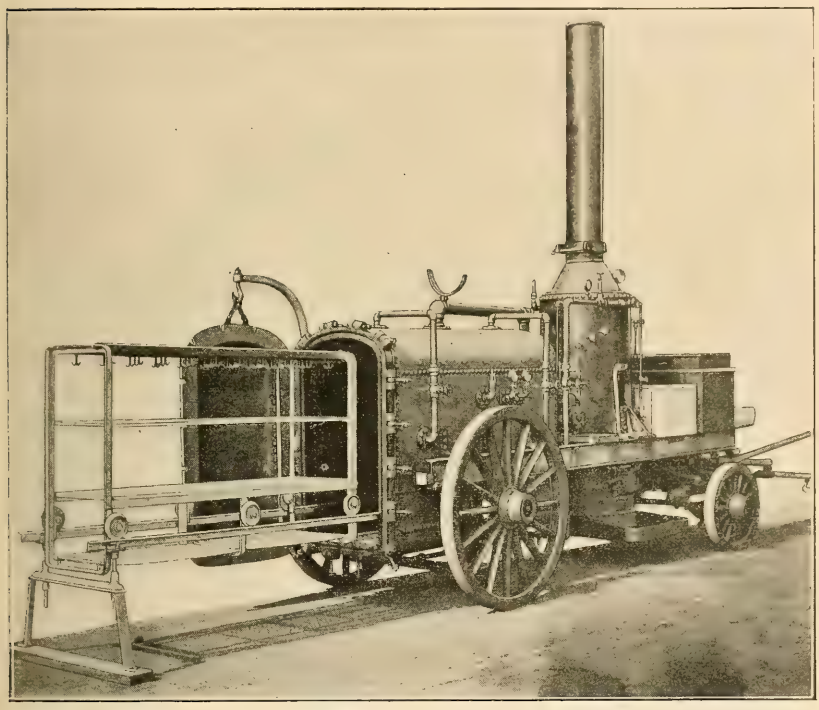


Arnold steam sterilizer; Boston Board of Health pattern. Adapted to the sterilization of milk, dressings, instruments, and articles of small bulk.

Large bundles, such as mattresses, pillows, bolsters, carpets, etc., are best disinfected by steam in a large disinfecting chamber especially constructed for materials of this kind. The plan of such a disinfecting oven is shown in Fig. 109. It consists of a receptacle or chamber into which the material to be disinfected is placed; the apparatus must be so constructed as to permit of being tightly closed; the chamber must be insulated. The wall of the receptacle should be double, with an intervening space which can itself be heated by live steam. The outside wall surrounding this space, called the steam jacket, should be insulated to prevent the rapid loss of heat from the interior. The materials to be disinfected are placed in the inner chamber, which is then closed. The steam is admitted to the jacket, thereby raising the temperature of the container—a procedure which is necessary to prevent the rapid condensation of the steam when

admitted to the inner chamber; condensation is to be avoided, as it causes saturation of the articles undergoing disinfection. After exposure for the requisite length of time the steam is turned off from the inner chamber while the jacket is kept hot. Air is then slowly

FIG. 109.



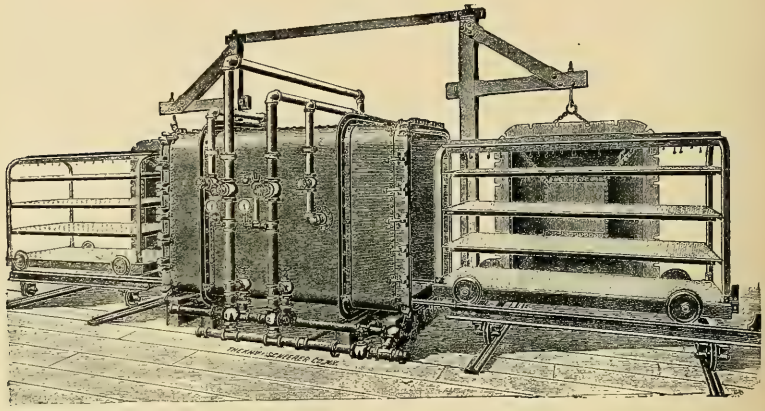
Kinyoun-Francis portable steam disinfector ready for service. This form of portable disinfector is especially recommended for house-to-house disinfection.

admitted, thereby driving the steam from the material undergoing disinfection and preventing the articles from becoming saturated as a result of condensation.

Steam under pressure.—Apparatus for applying steam under pressure must be constructed upon the principle already given for the large steam disinfecting appliances just described. It must, however, be much more strongly constructed, and competent to stand a pressure of at least fifteen pounds to the square inch in the inner chamber, while the space between the inner and outer shells—usually spoken of as the jacket—should bear a pressure of at least one hundred pounds to each square inch. In order to disinfect to the best advantage in such a chamber the material should be placed in position in its interior and the doors closed. The steam is then admitted to the jacket, which is gradually raised to the maximum

temperature, which, of course, depends upon the free circulation of the steam at a given pressure. In the meantime, in the most improved apparatus the air is exhausted from the interior until a pressure of less than half an atmosphere is obtained. The steam is now permitted to flow gently through the articles to be disinfected, gradually, however, raising the pressure to fifteen or eighteen pounds to the square inch. The pressure within the chamber is raised and lowered by valves controlling the ingress and egress of the steam, thus imi-

FIG. 110.



Chamber for disinfection by steam; adapted for municipal uses. The apparatus can be used for (*a*) disinfection in flowing or streaming steam; (*b*) disinfection by steam under pressure; (*c*) disinfection by superheated steam, and by the addition of a suitable generator as advised and employed by Kinyoun; (*e*) disinfection by formaldehyde gas. Properly constructed and in place the chamber should be so arranged that each end projects into a room, the two rooms not communicating except through the chamber. One room should be reserved for the reception of infected clothing and the other for the storage and handling of that which has been disinfected. Trucks for carrying material are also shown.

tating in a crude way the compression and relaxation applied to a sponge when attempting to saturate it with a fluid. After sufficient time has elapsed to permit thorough penetration of the materials within the heat is turned off from the interior in order to facilitate drying, so that articles are removed quite as dry as they were when placed in the chamber.

Disinfection by superheated steam possesses no advantage over disinfection by hot air; it is applied by admitting steam to the interior of the disinfecting-chamber at a temperature of 100° C. (212° F.). The steam is then turned off from the interior and the temperature of the jacket is raised, which superheats the steam contained in the disinfecting-chamber. Under such circumstances the results are practically those of disinfection by hot air.

Disinfection by steam has certain limitations: many articles are destroyed by its application—*e. g.*, leather, materials containing glue,

furniture and bound books, bodies containing oils and resins. For application on a large scale it is expensive.

The duration of exposure varies with the conditions. Loosely packed articles in which penetration is rapid do not require as long exposure as larger or more compact bundles. The best appliances for the use of steam are supplied with contact thermometers, that may be placed in the centre of thick masses and connected, through a tubulature in the wall of the chamber, with annunciators on the exterior that register the temperature on the interior, and the duration of the process is calculated from the time at which the desired temperature is reached.

Practical Application of Disinfectants.

In considering the applicability of various agents and means for attaining disinfection, reference has been made to the necessity of securing intimate contact between the disinfectant and the material to be disinfected. In order to secure this, mechanical and to a certain extent chemical cleansing may be necessary. Many solid or semi-solid bodies, such as fæces, must be suspended in the disinfecting solution. The surfaces of floors, walls, latrines, etc., may be covered with desiccated dirt of one kind or another, often practically impermeable to disinfecting agents. Such masses must be softened by moisture, or if necessary by the use of soap and water, strong alkalies, etc. For the cleansing of floors, soft or liquid soaps or soap powders are advised. It must be remembered that many of these are injurious to highly polished surfaces. Alcohol and ether may find special application, as in the disinfection of the skin and hands. Such agents are of special value for the removal of oils that materially impede the penetration of disinfecting solutions, but are injurious to varnished or polished surfaces.

An important point never to be lost sight of is the danger of reinfecting material which has been disinfected. One of the best examples of the necessary precaution against this danger is made manifest in the construction of the modern disinfecting plant for a city. The plant is divided into two parts that do not communicate except through the disinfecting-chamber. The infected materials are received in one side, or end, of the building, loaded upon cars which are pushed into the disinfecting-chamber, and the door closed. Disinfection is then proceeded with as already directed, and when completed other employés, who have not come in contact with the infected material, remove the now disinfected articles with the carriage from the other end of the chamber, which projects within the part of the building intended for the reception of disinfected goods only. The car is now pushed outside of the building and delivered to the infected

side for reloading. It is unnecessary to say that employés in the two departments should never come in contact while on duty.

Instruments should never be handled after disinfection except by hands that have been prepared for the purpose. In the disinfection of a room, as will be further described, the outer clothing worn by those in charge should be left in the room, or in other ways cared for, as during the preparation of the room the wearing-apparel must of necessity have become infected.

The foregoing directions are often regarded as of minor importance, but, unless such precautions are constantly observed, the whole process becomes untrustworthy. It is this strict attention to every detail that makes any reasonably satisfactory method trustworthy and far superior to the best means indifferently applied.

Rooms.—In fortunate instances it may be possible to choose the room which is to be infected. Thus, as soon as the diagnosis points toward the presence of an infectious disease, the attending physician may be able to select the apartment in which the patient is to be lodged during the course of the illness. Under such circumstances it is scarcely necessary to say that a large, airy, and well-lighted room should be chosen. It should be selected with the idea that after the patient's recovery it must be disinfected, and therefore delicately tinted paper should be avoided or at least those interested should be advised that it may be necessary to destroy the paper in the subsequent disinfection of the room. Carpets, curtains, drapery, upholstery of all kinds, and to a certain extent the wall decorations should be removed. As many object to absolutely bare walls, a few valueless pictures that may be destroyed at the termination of the illness are permissible. In the case of children an abundance of cheap lithographs and process colors are allowed for the purpose of relieving the monotony of confinement to the sick-bed. It is to be remembered at the beginning that after the apartment is once occupied nothing is to enter which cannot leave the room in a disinfected condition. The room should, if possible, communicate only indirectly with the other rooms. It has been recommended that in addition to the door which guards the communication with other parts of the house a pair of sheets or blankets may be suspended on the outside of the entrance, preventing so far as possible atmospheric interchange through the door. As further protection, these may be moistened with some disinfecting solution, and for this purpose corrosive sublimate is to be commended. The room should contain no upholstered furniture. The bed-covers should be of materials that can be washed. Instead of a single thick mattress, two thin mattresses are to be recommended, and between the two an impervious rubber sheet may be placed for the protection of the lower mattress. It is advised that thin mat-

tresses be selected, for the reason that they are more readily disinfected at the termination of the illness than the thicker ones. A form of cotton mattress can be obtained that is sufficiently cheap to permit of its being destroyed after recovery. Such a mattress affords a comfortable bed for several weeks, or at least throughout the course of any of the acute infectious diseases. As further protection, mattresses should be covered by several layers of folded linen. Iron beds with woven-wire springs are especially recommended, although, of course, a wooden frame may be disinfected. The so-called box type of springs, in which the springs are retained within boxes covered by heavy webbing, are to be condemned. If the room communicates with a bath-room which can be excluded from the remainder of the house, so much the better, but such a favorable condition is rarely to be expected. A cheaply constructed screen, the cover of which is formed of some readily antisepticized material, may be thrown across a corner or part of the room, thus affording a nook in which vessels for the reception of articles to be disinfected may be stored, and a place for the temporary deposition of disinfectants.

If the room is large, there may be thrown across the end, near the door, a line upon which can be supported sheets that have been disinfected in corrosive sublimate and dried, thereby curtaining off a narrow space of a few feet (its size depending upon the room) and affording a further safeguard for the remainder of the house. As already stated, it must be borne in mind that everything that is brought into the room must be of a kind permitting its disinfection before leaving the infected apartment, and excreta and materials such as slops and washing-water must be removed from the room in a disinfected condition.

During the illness of the patient sweeping and dusting with dry brooms, dusters, etc., are to be prohibited. All surfaces are to be wiped with cloths moistened in 1 : 1000 solution of corrosive sublimate or 5 per cent. solution of carbolic acid. As the odor from the last-named agent is likely to be objectionable, the mercury is usually to be preferred. As already stated, the floors should be free from carpet; but should an infective disease escape detection until it is certain that the carpet is infected, the practitioner usually permits the carpet to remain in the room and to be disinfected at the end of the illness. The writer is of the opinion that the plan should be condemned; and as there is nothing more difficult to disinfect than carpet, it should be removed at the earliest possible moment and disinfected as will be hereafter advised. Should it, however, be impracticable to remove the carpet or should there be other reasons for its retention in the room, it should be brushed with a broom moistened

in some disinfecting solution such as corrosive sublimate or carbolic acid. The bare floor should be wiped with a disinfecting solution. There is, however, not infrequently considerable prejudice against wetting the floor, as it is feared that injury may be done the patient by the dampness resulting from this precaution. Upon this point the writer would not venture to express an opinion, although he doubts, except under very peculiar circumstances, the possibility of harm to the patient. Instead of mopping the floor with a disinfecting solution, it has been suggested [1] that it be sprinkled with tea-leaves or saw-dust that has been previously saturated with a disinfecting solution. The sweepings should, of course, be immediately incinerated. In Paris and Berlin corrosive sublimate and carbolic acid solutions are recommended for cleaning the floor.

Disinfection of soiled linen, etc., removed from time to time from the room will be considered separately.

The disinfection of the room at the termination of the illness may be secured in a number of ways, and the method selected will depend, to a certain extent, upon the size, condition, and contents of the room. If the room is not very clean (or has not been kept scrupulously clean during the illness), if it contain carpets, curtains, draperies, and other hangings, it may be well to give it a preliminary disinfection, hoping thereby to render it safe for those who prepare it for the final disinfection. By this method, as soon as the patient has been removed from the room, as will be described later, the windows are closed and sealed, either by calking around the sides and between the sashes, or by pasting along the crevices strips of adhesive paper. The calking is easily done by using strips of fabric, candle-wick or cotton, and an ordinary case- or table-knife, with which the material is thrust into the crevices. Although more tedious and expensive, putty is best adapted to the satisfactory sealing of windows. Sheets moistened in formaldehyde as already described (see page 560) may be thrown over the backs of chairs and the bed, or suspended by cords from gas-fixtures, etc., and the room closed for twenty-four hours. At the end of this time the definite disinfection should be attempted. The operators who are to prepare the room for disinfection should wear rubber overshoes and linen dusters buttoning closely at the neck and extending to the feet, or, what is better, overalls, and a waist or short coat made of denim. If the room has had a preliminary disinfection, the windows are, of course, properly sealed, and for the comfort and to a certain extent the safety of those employed it may be wise to break the seal and open one of the windows.

In cities where a steam disinfecting plant is available, the mat-

[1] Department of Health, Chicago.

tress, pillows, cushions, or other bulky pieces that would not be penetrated by disinfectants to be used in the room are placed in air-tight bags and removed to the station for disinfection. If a carpet is present in the room, it is loosened from the floor and sprayed[1] on both sides with carbolic acid solution, rolled, and placed in an air-tight receptacle, in which it is removed to the disinfecting plant.

Spraying is conceded to be superior to rubbing down the walls with bread, as originally recommended by Esmarch. The walls may be mopped with a sponge moistened in a 1 : 500 solution of corrosive sublimate; the same solution or a 5 per cent. solution of carbolic acid may be applied to the woodwork. If the walls are papered with delicate paper, it may be hoped that the formalin disinfection that follows may thoroughly destroy any bacteria upon the surface. If the floor is clean—free from grease, dried dirt, or sputum—it may be mopped with a 1 : 500 solution of corrosive sublimate or a 5 per cent. solution of carbolic acid. If, however, it is soiled, better results will attend the use of lysol or creolin, as they contain soaps; 5 to 10 per cent. aqueous solutions should be used. The furniture should be rubbed with a 1 : 1000 solution of corrosive sublimate; formalin or creolin may be used, although the soap contained in the latter may injure highly polished articles. Upholstered articles should be sprayed. Delicate colorings may be injured by the spraying, and it is alleged that with the concentrated formaldehyde disinfection recommended (see page 563) spraying is not necessary. Mirrors, picture-frames, and the glass in the frames should be treated as directed for the furniture. After completion of the foregoing applications, the window should be closed and sealed as already advised. The operators now wash their hands and faces in a disinfecting solution, as will be recommended for disinfecting the skin, and remove the over-garments, which may be thrown in a disinfecting solution or spread over chairs. The door is now closed and sealed by means of strips of adhesive paper around its edges, and formalin injected into the room through the key-hole, as directed on pages 561 and 562.

As formaldehyde is thought to be most efficient in a dry atmosphere, many reverse the process as here commended, using the formaldehyde first, followed by the application of other disinfectants and thorough cleaning.

Remarks on Disinfection of the Room.—The foregoing method

[1] The spray used is the ordinary spray foot-pump used by florists and arboriculturists, supplied with a short rubber tube and a fine rose nozzle. The spraying solution consists of a 1 : 1000 corrosive sublimate mixture; to each 1000 parts, 5 of common salt are added. Gerlach recommends lysol in a strength of 3 to 5 per cent. aqueous solution; Wyatt Johnson recommends a 1 per cent. solution of formaldehyde; while the English health officers prefer a 2 to 5 per cent. solution of the latter agent.

can rarely be carried out in its completeness. It must be confessed that it is rather more ideal than feasible. Still the writer has seen it applied with all the detail advised. Modifications that may be rendered necessary are as follows:

1. There may not be a disinfecting station available, and therefore mattresses, pillows, cushions, etc., must be disinfected in the room. This can be best accomplished by thoroughly spraying with formaldehyde, or possibly by trusting to a concentration of gas in the room introduced from the outside (see page 561).

2. In many cities it is not the custom to wipe down the walls as directed, as it is believed that the formaldehyde disinfection destroys the bacteria present.

3. If the floor be clean, it may not be necessary to mop it with a disinfecting solution.

4. Where a formalin generator is not at hand sheets wrung out of formalin may be used as recommended (see page 560).

5. The formalin disinfection may be accomplished by vaporization of paraform according to directions given (see page 563).

6. In case formalin is not to be obtained or cannot be applied, sulphur fumigation as directed on page 134 may be substituted.

7. If for any reason it is impossible so to close the room as to render disinfection by gas, either formaldehyde or sulphurous acid, possible, a thorough spraying with corrosive sublimate, scrubbing the floor and cleaning the walls, woodwork, furniture, etc., may be trusted.

If no gaseous disinfectant has been used, the room should be thoroughly aired and exposed as much as possible to direct sunlight for a number of days before it is again occupied. The upholstered furniture, mattresses, bed-linen, etc., should be aired and exposed to the sunlight. All linen that will not be injured by the process should be immersed in a 5 per cent. solution of carbolic acid, lysol, or creolin, and subsequently boiled. Corrosive sublimate may be efficient for this purpose, but has the objection that it fixes organic stains, such as those of blood and fæces, so that subsequent removal becomes almost impossible. Formaldehyde is open to the same objection.

If the room has been disinfected by gaseous disinfectants, it should be kept closed twenty-four to thirty-six hours, and afterward opened and aired as directed.

Disinfection of Excreta.—It may be taken as not within the scope of this article to consider disinfection of excreta in the form of sewage.

Privy-vaults.—Probably the best results will be obtained by the addition to cesspools of a quantity of chloride of lime necessary to

give a 4 per cent. solution. A requisite to disinfection is the thorough mixing of the agent with all parts of the material to be disinfected. Where the contents of the cesspool or privy-vault are fluid this admixture is easily accomplished. If, however, the material to be disinfected is more or less solid, or completely so, it may be necessary to add sufficient water to render the agent thoroughly miscible with the excreta. Corrosive sublimate is not trustworthy as it is decomposed in the presence of albumin. Carbolic acid, creolin, and lysol are reliable but expensive. A 20 per cent. solution of milk of lime may be added to the contents of the vault or cesspool, the quantity requisite being at least two parts of the milk of lime to ten parts of the material to be disinfected. Cesspools and vaults that are walled with brick or concrete may be cleaned and thoroughly limed with the whitewash prepared as directed (see p. 556).

Water-closets.—The bowls and traps of water-closets should be kept sprinkled with chloride of lime, or they may be disinfected by the use of carbolic acid, lysol, or creolin; a 10 per cent. solution of formalin is also to be recommended. Chlorinated lime, or milk of lime, may be applied by means of a mop prepared by wrapping a stick with waste or cloths; this mop or swab is kept in the lime when not in use, and therefore lasts but a short time. Its cheapness renders it readily replaced.

Fresh Excreta.—The excreta should be received in a container in which disinfection can be accomplished. For this purpose agateware or earthenware is to be preferred. It has been advised that the disinfectant be placed in the vessel which is to receive the stool. There can be no doubt of the wisdom of this procedure, providing the precaution is taken to avoid the disinfectant coming in contact with the patient or being spilled on the bed or bedclothing. If the disinfectant is as strong as it should be, it may lead to more or less irritation if, in case of accident, it comes in contact with the skin. The writer has seen bedsores, in typhoid patients, following the accidental contact with the disinfecting solution. The disinfecting solution should be kept on hand in such a strength that its dilution with an equal quantity of excreta will not render it inefficient. Of the various solutions to be recommended, carbolic acid, lysol, creolin, chloride of lime, and milk of lime may be used. Concentrated solutions of corrosive sublimate rendered acid by hydrochloric acid or tartaric acid, as already advised, will also be found efficient. The disinfectant should be thoroughly mixed with the stool by vigorous stirring, and should be allowed plenty of time for action, not less than one-half hour, during which time the container may be closely covered. Gerloczy recommends boiling solutions of alkalies, concentrated lye, or carbonate of sodium (washing-soda) in the strength of 2 to 5 per cent. The objec-

tion to boiling water, which may be used, is that it drives off the gases present in the stools and impregnates the atmosphere of the room with offensive odors. Its efficiency if properly applied is admitted. After sufficient time has elapsed for the completion of disinfection the stool may be emptied into the water-closet, privy-vault, cesspool, etc. In country districts where no sewage system is used, and often where cesspools and privy-vaults are not accessible, an excavation should be made in the porous earth, and into this the disinfected stool should be deposited. The excavation, which should be two or three feet in depth, can be covered by a barrel, and as soon as accumulation occurs at the bottom it should be filled in and a new receptacle prepared. This precaution is necessary by reason of the fact that many of the disinfectants are poisonous, and it is also a further precaution against the danger of failure properly to disinfect the stool. It is unnecessary to say that such receptacles should not be in the neighborhood of a well, cistern, or water-course.

Waste water from the sick-room may be disinfected by the addition of corrosive sublimate, carbolic acid, lysol, or creolin. The corrosive sublimate kept in solution as already advised may be easily applied.

Towels and bed-linen coming from the infected room should be handled as follows:

A covered bucket or wash-boiler, or other suitable receptacle, containing 5 per cent. solution of carbolic acid or lysol, or creolin, should be placed just inside of the door. The articles to be removed from the room are thrown at once into the disinfecting solution and kept in the room until disinfected, after which they are passed out of the door in the disinfectant. The solution in the bucket or boiler should be kept at hand, in the room, to receive soiled articles that should not be permitted to accumulate without disinfection. In the absence of other disinfectants the clothing, towels, etc., may be thrown directly into the boiling water and boiled. This, of course, insures disinfection; it is not, however, always feasible; under such circumstances chemical disinfection must be relied upon.

Infected materials that cannot be disinfected before removal from the sick-room should be wrapped in a towel or other fabric, wrung out of a disinfecting solution, such as corrosive sublimate or carbolic acid. This method is preferred by some to removal in a disinfecting solution, as already advised.

Dishes carrying food, containers for water, medicine-glasses, spoons, knives, forks, etc., should not leave the room except in a disinfectant, and for this purpose boiling water is alone permissible.

Mattresses, pillows, cushions, and similar articles are best disinfected by steam, although, as already indicated, formalin disinfection,

particularly if the agent be applied in a concentrated form and permitted to remain long in contact with the article, may be trusted. Carpets had best be disinfected in the same manner, although a sprinkling with corrosive sublimate has been recommended (see p. 575).

Clothing.—Fabrics of linen and cotton that bear washing should be treated as already commended for towels and bed-linen. Other fabrics can be disinfected by moist heat, and still others by dry heat. Clothing which cannot be disinfected by heat, and that will not bear immersion in carbolic acid and formalin solutions, may be subjected to gaseous disinfection; in order to accomplish this it is suspended in a closet, box, case, trunk, or other suitable receptacle, and treated by formalin gas generated by some of the methods already given. As already indicated, it must not be packed, but should be loosely exposed to the disinfectant; in order to insure disinfection the gas should be concentrated, say, one liter of formalin to the thousand cubic feet of space.

Disinfection of the Skin.—A patient recovering from any of the infectious diseases, such as scarlet fever, smallpox, etc., retains in the skin for a considerable length of time a moderate degree of infectivity. The skin should be thoroughly cleansed by means of soap and warm water, the water used as hot as can be comfortably borne; this should be thoroughly applied, and finally the soap removed by boiled water which has been permitted to cool to a temperature that can be safely applied. The skin should then be bathed with slightly diluted alcohol (70 per cent.). The water and soap followed by the alcohol prepare the skin for disinfection, although a large percentage of the bacteria will be removed during the process. The skin is now washed in a 1 : 1000 solution of corrosive sublimate or in a 5 per cent. solution of carbolic acid; in the case of children and individuals possessing an extremely delicate skin the solutions recommended may prove too strong, and under such circumstances should be diluted one-half, although disinfection with weakened solutions is less likely to be efficient. The carbolic acid is not as safe as the sublimate solution.

Hands.—By reason of the peculiarity of the cutaneous covering—the thickened epidermis with many furrows and ridges, the finger-nails, the subungual spaces and crevices at the margin—disinfection of the hands is rendered most difficult, although the thick and resisting cuticle permits the use of stronger disinfecting solutions than could be applied to the body as a whole. The hands should be prepared for disinfection as already described, and in addition the soap and water should be applied by means of a reasonably stiff brush that has been previously sterilized by heat. The subungual spaces must be cleaned first with a nail-cleaner, followed by a vigorous

brushing. In Welch's method, after preliminary cleaning and the removal of the soap by means of sterile water the hands and forearms are immersed for two minutes in a saturated solution of permanganate of potassium slightly warmed. The solution is rubbed into the skin by means of a sterilized swab of absorbent cotton. The hands are then removed from the permanganate solution and immersed in the same manner in a saturated aqueous solution of oxalic acid. This is followed by sterile water as warm as can be borne, and finally disinfection completed in a 1 : 500 solution of corrosive sublimate, which is followed by washing in sterile water. Unfortunately, many individuals bear the repeated use of corrosive sublimate poorly. For such the preliminary preparation of the hands may be followed by the use of a 5 per cent. solution of carbolic acid, which has the disadvantage of benumbing the skin; or lysol or creolin may be used.

The biniodide of mercury in a 1 : 1000 aqueous solution may be substituted for corrosive sublimate (see page 554), or iodine trichloride may be employed (see page 554).

Merchandise.—This is one of the most intricate problems with which the sanitarian has to deal. It is alleged by many sanitary officers that absolutely new goods, coming from uninfected places, demand only disinfection of the outside of the container, which may be accomplished by fumigation with sulphur or formalin. Infected rags give rise to the most difficulty and always constitute a source of danger. As here considered, it is not meant to include soiled articles coming from the sick-room, which have been dealt with elsewhere, but the bags, bundles, and bales of commerce. Where the rags are accessible, as at the point of collection, they can probably be best disinfected by steam. In the process of transportation the rags are always in bales, in which condition it is impossible to disinfect them. Where there is any suspicion that baled rags contain infection, the only solution of the difficulty is to open the bales and expose the rags to steam or possibly formaldehyde, or, better, boiling water. The writer is informed that disinfection by corrosive sublimate, carbolic acid, and most other chemical agents prevents the use of the articles for the purpose for which they were collected.

Mails.—The disinfection of mail matter is best secured by means of dry heat, which should approach a temperature of 140° C. This, as a rule, renders the paper brittle and sometimes crumbly. It may be necessary to enclose articles in new containers. It is maintained that properly perforated envelopes and small packages can be disinfected by sulphur or formaldehyde fumigation.

Books.—The most satisfactory, although not perfectly reliable, method is by formaldehyde fumigation. The books are widely opened and placed in a suitable container—air-tight box, closet, or

receptacle constructed for the purpose—and subjected to the fumes of formaldehyde. The writer recently had occasion to superintend the disinfection of a valuable collection of books which had been constantly handled by a consumptive. Complete sterilization, as demonstrated by inoculation- and culture-experiments, was accomplished after twelve hours' exposure to an atmosphere containing 5 per cent. per volume of gas. In the experiment just mentioned the books stood on end open with the leaves separated; they could be suspended by the backs; it is necessary that they be widely opened. If the formaldehyde is liberated from an aqueous solution the presence of moisture would endanger the bindings; for this reason the use of tablets (p. 563) is advised.

Ships.—These are practically always disinfected at a suitable station or where satisfactory methods for disinfecting on a large scale are available. The bedding, carpets, and furnishings should be disinfected by steam. The walls, floors, cabin, and other apartments may be disinfected by formaldehyde gas. The same agent may be used for the disinfection of mattresses, etc., but it is requisite that they should be contained in an air-tight space and applied as directed (see page 563). In the absence of apparatus for formaldehyde or steam disinfection the methods already advised for the disinfection of a room may be applied.

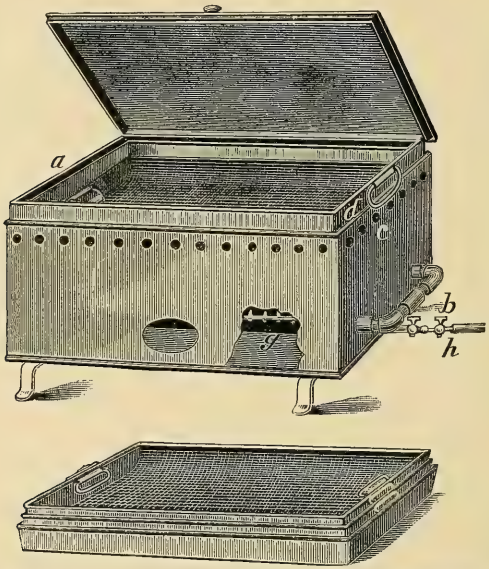
In steamships the boiler affords an abundant source of steam, and often this may be utilized. Forecastle, steerage, or other suitable apartment may be selected, that can be closed tightly by doors or sealed hatches. When possible the wall of the room or other space should not be a part of the hull or upper deck, as it is impossible to raise the temperature of the outside walls, especially in iron or steel vessels, and the abundant condensation saturates with water the articles undergoing disinfection. All articles to be disinfected are placed in the space selected and live steam is turned on. A thermometer is introduced through an opening somewhere in the wall of the room; a large keyhole, or the knob of a door may be removed and the resulting hole utilized, or a ventilator-space or other orifice can always be found. From time to time the thermometer is withdrawn and read, and the exposure timed from the moment at which the desired temperature is recorded. Rarely can a temperature exceeding 76° C. (170° F.) be reached, and at least two hours' exposure will be necessary for the destruction of non-spore-bearing bacteria.

Railroad Coaches.—Day coaches and dining-cars may be disinfected by formaldehyde gas as directed for rooms. It is sometimes advised to use a preliminary disinfection, after which the carpets are pulled up, cushions loosened, and curtains permitted to drop so as to expose all parts of the car, to which a second

disinfection is applied. One of the greatest difficulties is to render the car reasonably gas-tight. The water-closets, urinals, and ventilators must be closed, preferably by waste. Immigration coaches and sleeping-cars require special care in disinfection. Careful mechanical cleansing is of absolute necessity. Berths must be thoroughly exposed and formaldehyde freely applied in a concentrated form (see page 563). In the absence of formaldehyde, sulphur disinfection is permissible, but should be followed by thorough mechanical cleansing and spraying with corrosive sublimate or carbolic acid.

Surgical Instruments.—For instruments that will bear it there is nothing comparable to heat. This is best applied in the form of boiling water, although steam is permissible. A covered pan, kettle, or boiler previously thoroughly cleansed may be used for the purpose; of the many sterilizers especially adapted to this purpose may be mentioned the modifications of the Arnold steam sterilizer (Figs.

FIG. 111.

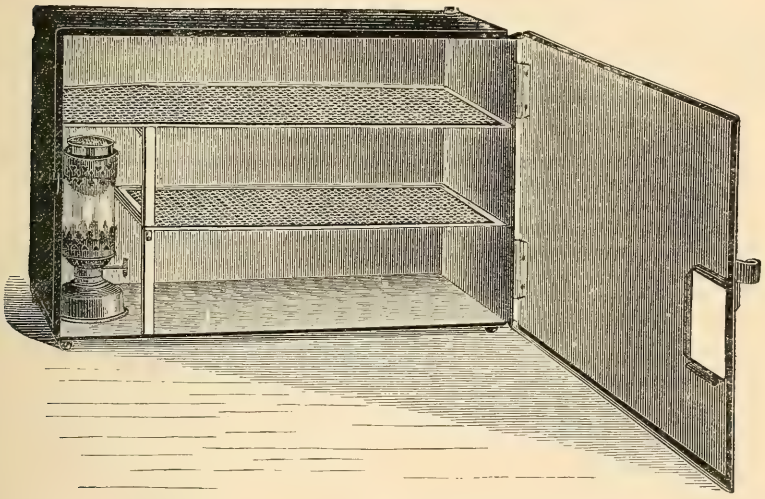


Schimmelbusch's sterilizer for surgical instruments. *a*, water-chamber sufficiently large to receive the wire pans shown in the lower part of the illustration. *b*, air inlet to burner. *c*, Russia-iron or copper exterior. *d*, seal for lid when in position. *g*, burner. *h*, cocks controlling gas inlet.—*Park's Surgery.*

107 and 108), and Schimmelbusch's instrument boiler (Fig. 111). For instruments to which heat can be applied it has superseded all other methods of disinfection. The penetration of heat, the cleansing of the instruments, and the prevention of rust are favored by the addition of an alkali, preferably about a teaspoonful of washing-soda to a quart of water. As boiling injures many instruments,

such as catheters, rubber bags, and other appliances made of soft rubber, wax, composition, etc., it becomes necessary under certain circumstances to employ some form of chemical disinfection. A 5 per cent. solution of carbolic acid, lysol, or creolin may be used. These agents act to advantage if gently warmed. It is not necessary, however, to carry the temperature above 50° or 60° C. Corrosive sublimate cannot, of course, be applied to metallic instruments, but may be used for glass, rubber, etc. The strength recommended is usually 1 : 1000. In the same strength mercuric iodide is said to be less injurious. Hypodermic and other syringes containing rubber or leather packing are injured by repeated boiling. The needles may be boiled, the cylinder must be cleansed of all oil by alcohol, followed

FIG. 112.



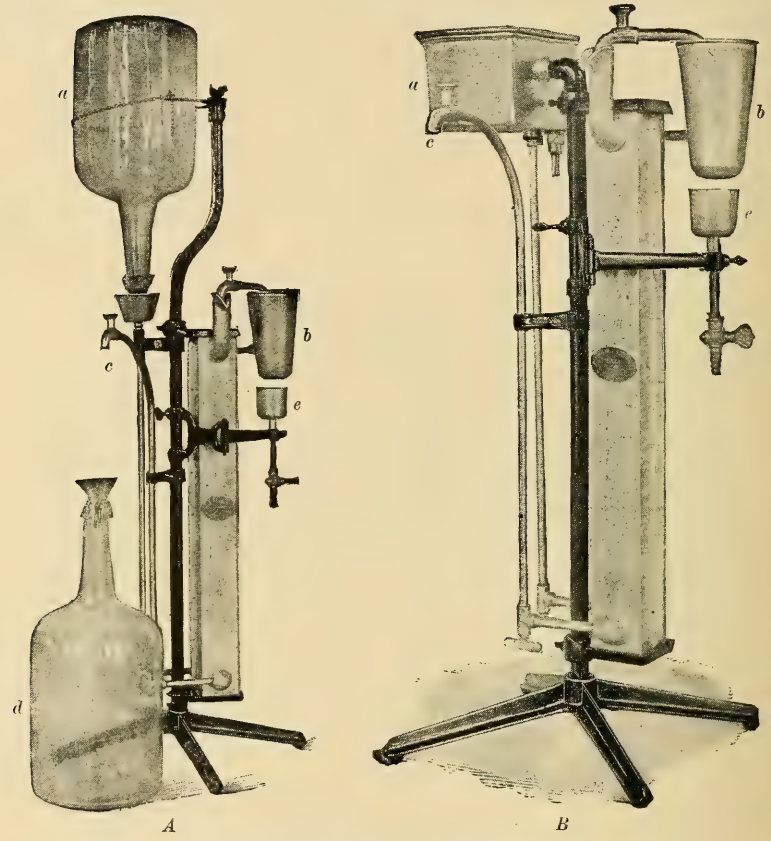
Metallic box for the disinfection of instruments by formaldehyde. The gas is evolved from paraform by means of the small lamp (see Fig. 103, p. 563) shown on the left. The method is believed to be especially applicable for instruments and appliances that cannot be disinfected by heat—*e. g.*, catheters.

by ether, and this again by alcohol. The syringe may then be placed in a 5 to 10 per cent. solution of formalin for from twelve to twenty-four hours, when its disinfection will usually be complete. It should be rinsed in boiled water before using.

Food.—During epidemics of water-borne diseases, such as cholera, it becomes important to disinfect all foods. Of course, heat is the only reliable method which can be used under the circumstances. To many articles this is not applicable, among which may be mentioned the salads and cresses, and these should therefore be prohibited. The most important food requiring sterilization is milk. It is now maintained that a number of infectious diseases may be milk-borne;

thus diphtheria and scarlet fever, and—probably most frequent of all—tuberculosis. It is conceded that disinfection directed toward the tubercle bacillus will be sufficient for other pathogenic organisms

FIG. 113.



Forbes' apparatus for the sterilization of water.

A, portable form. *a*, large bottle in which the water to be sterilized is placed. This empties, by means of an automatic feed, into the conducting-tube shown in the figure as receiving the neck of the bottle. The conducting-tube communicates with the square metallic box, which is divided longitudinally into two parts by means of a corrugated diaphragm. The unsterilized water passes upward on one side of the diaphragm and into the cup *b*, where it is boiled, over into the other compartment, from which it passes out at the cock *c*, and is received in the container *d*. The apparatus is so constructed that the water cannot escape boiling, and the boiled water is cooled by the incoming unboiled water, the temperature of which is at the same time gradually raised to nearly the boiling-point. This ingenious arrangement assures economy by utilizing the available heat. The water delivered from the apparatus is aërated, and therefore palatable.

B, larger form of same apparatus, intended for connection with the water supply. The tank (*a*) is entirely automatic in filling and feed. The receptacle for collecting the sterilized water is not shown in the illustration, otherwise the lettering is the same as in *A*. *e*, in both figures, is the gas-burner for supplying the heat. For use in camp, and where gas is not available, a petroleum-burner is adapted for the purpose.

in milk, with the possible exception of anthrax, which is very rarely a contaminant. The experiments of DeMan indicate that a temper-

ature approximating 70° C. maintained for ten minutes is necessary. Observations in the pasteurization of milk show that changes in the proteids which involve alterations in the taste and digestion are first manifest at a temperature about 68° C. It is therefore important that this temperature should not be exceeded. It has been satisfactorily demonstrated that to insure the destruction of the tubercle bacillus at the temperature given it is necessary to make the exposure twenty minutes, or better a half hour; and above all it is important that the heating be uniform and not too rapidly applied, as in this way only a part of the milk may be raised to the requisite temperature. Of the many forms of pasteurizers recommended, those constructed on the principle of the Arnold sterilizer are to be preferred.

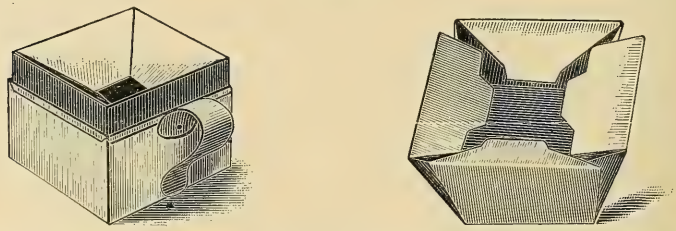
Water.—The disinfection of water is best accomplished by boiling. It may be boiled in a closed vessel and subsequently aërated, as freshly boiled water is flat and insipid. It has been demonstrated by the experience of medical officers serving with our military forces, both at home and abroad, that soldiers will run the risk of infection rather than use the tasteless boiled water. The Forbes apparatus for the sterilization of water is especially to be recommended (Fig. 113). The various processes of distillation are, of course, efficient, but require some time, and are therefore more expensive. The writer is not in sympathy with the so-called chemical disinfection of water by means of bromine, chloride of lime, etc., as the application of such agents requires the supervision of an expert. It is, of course, presumed that the various forms of filtration (mechanical purification of water) do not come within the scope of this article.

Cisterns and Wells.—Concrete cisterns, metallic tanks, and similar reservoirs may be disinfected by lime or carbolic acid, preferably the former. If not large, boiling water may be used, and when applicable is greatly to be preferred.

The ordinary well walled with stone or other substance giving rise to crevices cannot be disinfected, and when once infected should be condemned. In India, Hankin has attempted the disinfection of wells by means of permanganate of potassium. He recommends that an ounce of permanganate be placed in a bucket, which is filled from the contents of the well and emptied, being careful not to pour out the crystals, and that the solution rather than the crystals enters the well. The addition of the permanganate is continued until, when thoroughly mixed, the water retains a pinkish color for several hours; and at the end of twenty-four hours the water is drawn off, the walls cleansed and the well allowed to fill. In this way it is flushed a number of times in order to remove the permanganate. The interior of a well which has been thoroughly cleansed may be sprayed

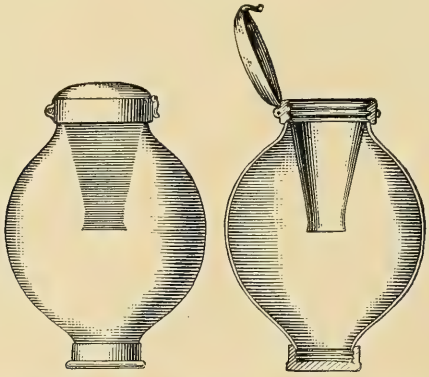
with carbolic acid or milk of lime. If the well contains a pump, the pipes should be disinfected. A thorough mechanical cleansing of the walls and bottom of the well is always to be commended. It may be stated in passing that evidence of infectivity in a well means that a point of bacterial ingress is present, rendering the continued use fraught with danger. It is unnecessary to remark that the dangerous

FIG. 114.



Sanitary cuspidor. This useful article is constructed largely of pasteboard retained in shape by a metal frame. The pasteboard is quite inexpensive, and should be destroyed by fire with the contained sputum.

FIG. 115.



Dettweiler pocket-flask. This ingenious device is intended for the reception of sputum, and is what might be called a portable cuspidor that can be conveniently carried in the pocket. It is made of blue glass, with flattened sides, and has a capacity of three fluidounces. It is so constructed as to permit of ready cleansing, is water-tight, and hence may be charged with a disinfecting solution.

character of most disinfectants demands their complete removal before the water can be used.

Sputum.—When sputum is dry or likely to become dry, as when on cloths, cloth handkerchiefs, or Japanese paper, as is recommended by some, burning is the safest and most convenient method of disinfection. Sputum should be received in a non-metallic cuspidor, which may contain a 5 per cent. solution of carbolic acid, lysol, or creolin. Corrosive sublimate is not to be recommended for the disinfection of sputum. The writer has no experimental data on the efficiency of

iodine trichloride, but its activity in the presence of albumin would indicate its special applicability for the disinfection of sputum. The irritant fumes emanating from solutions of the agent might be objectionable. Spittoons are more conveniently cleaned and more readily kept clean if the aqueous solution of the disinfectant contains an alkali. Of course, the alkalies to be used must be selected so as not to be incompatible with the disinfectant. If a Dettweiler flask is used, the most reliable and efficient disinfectant is boiling. Yersin has constructed a special sterilizer, employing heat for the disinfection of cuspidors used in the hospital wards over which he presides.

Corpses.—Those dying of infectious diseases should not be laid out upon or in any appliance which will be subsequently used elsewhere. For this reason icing-boxes should be prohibited. As soon after death as possible the body should be wrapped in a sheet saturated in a 5 per cent. solution of chloride of lime or a 10 per cent. solution of Labarraque's fluid. At the earliest moment the body should be placed in a coffin, the lining of which is thoroughly impregnated with formaldehyde, at least one liter being used. It is unnecessary to say that the coffin should be sealed hermetically. Most cities have laws prohibiting the transportation of bodies dead of contagious diseases. It is usually held, however, that if disinfection of the surface of the body and of the container by formaldehyde gas has been applied, transportation in air-tight caskets is permissible. Young has recommended that under such circumstances the coffin must be placed in a shipping-box and surrounded by an absorbent material, such as saw-dust, which has been saturated in formalin or hypochlorite solution (chloride of lime).

For the disinfection of carcasses of animals dead of bacterial diseases destruction by fire is especially to be commended; it is rarely applicable. The animals are usually placed in a pit, or excavation or depression of some kind, and quicklime deposited around and upon them. It is best that the animal be opened, so as to permit the lime to have access to the juices of the body; and in large carcasses, such as oxen and horses, it is best to eviscerate and fill the cavities with the lime, which should also be applied freely upon the viscera and external surfaces.

DISEASES OF THE THYROID AND THYMUS GLANDS, INCLUDING MYXŒDEMA, CRETINISM, GRAVES' DISEASE, AND OBESITY.

By S. J. MELTZER, M.D.

ABSENCE, DEGENERATION, OR ATROPHY OF THE THYROID GLAND.

Historical Sketch.—Our knowledge of the importance of the thyroid to the normal metabolism of the animal body is only of recent date. But a short time ago atrophy of the gland was not even mentioned in text-books, and experiments were quoted showing that the removal of the thyroid does not affect the condition of the animal in any respect (A. Bardeleben[1]); we possess at present abundant proofs furnished by modern surgery and experimental physiology that the presence of the thyroid is essential to the life and health of man and animals. Clinical medicine can present well-characterized diseases which have their origin solely in the atrophy or absence of the thyroid gland; and diseases which for a short period appeared to be hopelessly incurable can now be treated with infallible success. And still more: we recognize in the thyroid gland itself a therapeutic agent of great value and manifold use. The history of this entire chapter is exceedingly instructive, and I shall attempt to give a short outline of it.

In 1873, William Gull[2] read a paper before the Clinical Society of London on "A Cretinoid State supervening in Adult Life of Women." He has given a clear description of a few cases with peculiar symptoms reminding one of cretinism. In 1878, W. Ord[3] read a communication on "Myxœdema, a Term Proposed to be Applied to an Essential Condition in the Cretinoid Affection occasionally Observed in Middle-aged Women." The cases described by Ord were similar to those described by Gull. One of these cases came to a post-mortem examination. The jelly-like swelling of the connective tissue suggested the term myxœdema. The tissue of the thyroid gland was found to be entirely replaced by fibrous degeneration.

Soon after similar reports appeared in the medical literature of other countries also. Charcot[4] named this condition *cachexie pachydermique*. In the few cases which came to an autopsy the thyroid was invariably found to be degenerated.

On September 13, 1882, in a communication made before the Medical Society of Geneva, Switzerland, J. Reverdin[5] reported that patients whose entire goitrous thyroid was removed soon show a peculiar condition. About seven months later, on April 4, 1883, Kocher[6] of Berne read his classical paper on cachectic conditions following the total removal of the goitrous gland, to which condition Kocher gave the name of *cachexia strumipriva*. At that time Kocher did not think that the cachectic condition was due to the loss of the function of the thyroid. On May 15th J. and A. Reverdin[7] published an article on myxœdema following extirpation of the thyroid. These authors took the ground that the complex of symptoms following the total extirpation of the thyroid gland is simply myxœdema—*operative myxœdema*—and suggested the idea that both forms, myxœdema and cachexia strumipriva, are due to the loss of the function of the thyroid gland. In October of the same year, at a meeting of the Clinical Society of London, Felix Semon[8] made the further suggestion that the loss of the function of the thyroid is probably the cause of all the three states: cretinism, myxœdema, and cachexia strumipriva. At this meeting a committee was appointed to investigate the entire question.

Soon after the communication of Reverdin became known, it was recalled that M. Schiff[9] had reported as early as 1859 that the removal of the thyroid in dogs was followed by a general tetanic condition of the animal. These experiments were for more than twenty years entirely ignored. Schiff[10] repeated them again and confirmed his former results. This time his statement brought out quite a large number of experimental investigations, with the usual course: some investigators denying the facts, others admitting them, but explaining them by some fault in the technique, etc. Finally all the opposition was overcome, due especially to the excellent works of Ferdinand Fuhr[11] and Victor Horsley.[12] The committee of the Clinical Society reported its prolonged and thorough investigation in 1887,[13] and by the weight of this report, as well as by the many important contributions coming from many independent sources, the following conclusions were practically settled:

The thyroid gland exerts an important function in the body of man and animals. When a child is born without a gland, or the gland becomes degenerated spontaneously during infancy or childhood, a state of cretinism develops. If the degeneration occurs in adults, the result is myxœdema. The same results are obtained in

man when the thyroid is totally removed by operation. The removal of the gland in animals brings on an acute tetanic outbreak, a condition which occasionally occurs also in man.[14] The difference between man and animals is probably due to the fact that in animals a healthy thyroid is removed, while in man the operation usually removes the goitrous thyroid and the body was already adapted to a moderate impairment of the function of the gland.

Later experimental investigations have cleared up many former experimental failures. Some accessory glands which are scattered all over the neck and in the chest or even within the trachea were not removed. These remnants become hypertrophied after the removal of the main gland, and assume its function. The importance of the parathyroids which have a variable location in different animals has been gradually recognized. When these accessory glands and parathyroids are also removed, the *cachexia thyreopriva* can be produced even in rodents.

Of the American contributors to the literature of our subject, the treatise of Hun and Prudden[15] deserves special mention, as it ranks high among the writings on myxœdema and has been largely quoted by subsequent writers.

While thus the etiology and symptomatology of the new diseases were brought to a finish, their treatment seemed to be in a hopeless state. Pilocarpine, arsenic, strychnine, and other drugs and therapeutic measures were recommended and employed; but nobody could report a permanent improvement, not to speak of a cure. However, the experimental study of the function of the gland soon brought forth a new plan of treatment.

Schiff reported (1884) that the implantation of a thyroid in the peritoneal cavity of the dog alleviates the results of the removal of the thyroid from the neck of this animal. Kocher soon tried this method in the human cases of cachexia strumipriva, but did not obtain any improvement. Von Eiselsberg,[16] however (1889), who confirmed the statement of Schiff, and Bircher[17] (1889) succeeded in alleviating all the symptoms of cachexia, once for three months and once for nine months, in a case of operative myxœdema with tetany, by implanting a human thyroid in the abdomen of this patient. Independent of the attempts of Kocher and Bircher, Horsley[18] (1890) advocated this method for the treatment of myxœdema and cretinism. The advice was followed out by many surgeons by burying the thyroid of a sheep either in the abdominal cavity or in some place in the subcutaneous tissue. There resulted a decided improvement in all cases treated by this method, but in all cases sooner or later a recurrence of the symptoms took place. The expectation that

the gland would vascularize and discharge its function in the new place was not realized; the gland becomes absorbed.

Bettancourt and Serrano[19] noticed the improvement on the second day after the grafting of the thyroid; this could only mean that the absorption of some of the juice within the grafted thyroid caused the beneficial influence. Furthermore, Vassale[20] (1890) observed the cachexia in dogs obviated by intravenous injection of an extract of the thyroid gland. A similar statement was made by Pisenti.[21] Thus the road was paved to the idea that the juice of the thyroid extract introduced into some place in the body could obviate the effects of the loss of the thyroid gland.

George R. Murray, in February, 1891,[22] made the suggestion to treat myxœdema by subcutaneous injections of an extract of the thyroid. In the following April[23] he himself instituted this plan of treatment, and in July, 1891, he presented to the British Medical Association a case of myxœdema remarkably improved by this new mode of treatment.

The most important step was made by Howitz[24] of Copenhagen, who in June, 1892, reported that he obtained a curative effect upon myxœdema by the administration by the mouth of the raw or cooked thyroid. Similar statements were made by Mackenzie[25] and by Fox[26] in October, 1892. The treatment was soon applied also to cretinism and operative myxœdema, with equally good results. A further practical advance was made by converting the thyroid into more convenient forms of administration: extracts, powders, tablets of the thyroid, became handy therapeutical agents which got into general use all over the world with uniformly good success.

The combined efforts of physiology, medicine, and surgery have thus established the fact that in the absence of the thyroid gland a detrimental factor is rapidly developing within the body which causes the myxœdematous cachexia, and that the thyroid gland furnishes another factor which, when introduced into the body, either by natural or artificial ways, neutralizes the detrimental effects of the opposite factor.

It is now, then, an established fact, that the absence, atrophy, or progressive degeneration of the thyroid gland is the sole cause of myxœdema, a well-defined, newly recognized disease; of cretinism, an old well-known pathological condition, and of cachexia strumipriva, an offspring of modern surgery. Before entering upon a detailed presentation of the treatment of these diseases we shall proceed with a brief description of their symptoms.

Myxœdema.

Myxœdema is a disease of the adult, of idiopathic origin. Though occurring at all ages, the years between thirty-five and forty-five show the greatest number of cases. It occurs more frequently in women than in men (six to one). It has been seen nearly all over the world, but in some places more than in others. With regard to the exciting cause we have as yet no definite knowledge. There is in literature one case which was caused by syphilis,[27] another case by actinomycosis,[28] a few others were caused by the misuse of iodine (Mosler, Anderson, etc.), in a few cases Graves' disease preceded myxœdema (Baldwin, Bramwell, etc.), and in a few others there was a distinct hereditary predisposition (Ord, Hun and Prudden, etc.); for the vast majority of the cases, however, we have to state that the disease was of idiopathic origin.

The disease is recognizable at sight by the peculiar œdema and by

Fig. 116.

Myxœdema. Mrs. N., Nov. 22, 1893.

the "cretinoid" appearance (see Fig. 116). The œdema is solid, does not pit on pressure, and is not distributed according to the laws of gravity. The œdema of both lids, of the nose, of the lips, and of the supraclavicular region is most striking. The skin is dry, scaly,

and has a yellowish, waxy appearance. There are two bluish-red points on the cheeks, the everted lips are cyanotic, the gums spongy and bleeding easily. The hair on the head, axillæ, etc., is dry, faded, thin, and scanty, the nails are grooved and brittle. Temperature and pulse are below normal. The patient always feels cold and never perspires. The urine is rather scanty and generally contains some albumin. The bowels are constipated. The general movements are awkward and slow; so also is the speech. The mental capacity is affected, memory impaired, and hallucinations are quite a constant occurrence. There have been cases with real insanity.

The diagnosis should offer no difficulty. The character and the distribution of the œdema, the constant sensation of cold, and the total absence of perspiration will sufficiently distinguish it from Bright's disease and obesity, the only pathological conditions with which myxœdema could be confounded.

Cachexia Strumipriva.

Since the considerable progress which the surgery of the thyroid gland has made within the last twenty-five years, the total extirpation of the goitrous or otherwise affected thyroid has been often resorted to. In the surviving cases a state of cachexia was gradually developed which is in every respect similar to the cachexia of the idiopathic myxœdema. In some cases the cachexia is preceded by tetanic fits, which usually set in soon after the operation. The onset of the cachectic condition took place after a few weeks or even after a few months. In some cases the cachectic symptoms disappeared again after a few months' duration, on account of some normal gland-tissue which was left unintentionally, and which within these few months became hypertrophied, thus becoming enabled to provide the body with the necessary amount of thyroid secretion.

Cretinism.

There is an endemic and a sporadic cretinism. The former occurs in greater frequency, but is mostly confined to certain localities—to "goitrous districts;" the latter is less frequent, but is to be found in all parts of the world. In sporadic cretinism the thyroid is absent. In the endemic cretinism the gland is often rather hypertrophic, goitrous; the microscopic examination of these glands, however, has revealed a total degeneration of the follicular tissue. All forms of cretinism are simply infantile myxœdema; this might be congenital, or the onset might occur at any period between birth and puberty. If we now state that in addition to the œdema and the nervous symptoms seen in myxœdema of the adult the infantile myxœdema causes the arrest of the bodily and mental growth,

we can easily understand that the symptoms will vary according to the period at which the onset took place. Contrasted with the very short body of the cretin, the œdema of neck, stomach, etc. appears to be enormous. The broad and retreating nose, the retreating and narrow forehead, the very small gazeless eyes, the thick lips, and the protruding tongue present a beastly expression that, once seen, is never to be forgotten. The intellectual faculties are sometimes far beneath those of the beast. No speech, no understanding, no recognition, and sometimes no perception whatsoever—an absolute intellectual blank. It is not my task here to give a detailed description. The symptoms of the disease are multiform, but the diagnosis offers no difficulty; the characteristic œdema will distinguish it from idiotism, and there is no other disease which could be confounded with cretinism.

Treatment.

There are on record a few cases of these diseases for which it is claimed that they improved without any treatment. Of the post-operative cachexia we have mentioned above that in some cases the symptoms disappeared after a few months; that is, the accessory gland or the hypertrophied remnant of the normal gland-tissue, accidentally left over, attained a growth sufficient to take the place of the main part of the gland which had been removed. The case of myxœdema which was caused by syphilis was cured by anti-syphilitic treatment. The case which was complicated by actinomycosis of the thyroid improved after removal of the infected part.[1] Tetanic attacks are often alleviated by sweating. Myxœdematous patients feel better in summer and in a warmer climate than in winter and in a cooler region. Pregnancy has a favorable influence upon myxœdema; the myxœdematous condition, however, seems to prevent conception. Here may be mentioned also a method of surgical treatment of the thyroid devised by Poncet.[2] He exposes both thyroid lobes, dusts them with iodoform, or introduces pieces of ivory in order to increase the secretion of the thyroid. The inventor of this method terms it *exo-thyréopexie*, and claims to have attained a wonderful result by the application of this method in a case of infantile myxœdema.

The Thyroid Treatmemt.—The vast majority of all the cases reported in the medical literature were not improved until the thyroid treatment was instituted, but this therapeutic measure has indeed accomplished wonders.

The thyroid was employed as a therapeutic agent in five different

[1] The myxœdema reappeared and had to be treated with thyroid. (Burghardt, *Charite Annalen*, Bd. 22.)

[2] *Lyon médicale*, April, 1893.

ways: 1. The implantation of a thyroid from sheep or monkey (or human being) in the abdominal cavity or in the subcutaneous tissue of the patient; 2. The subcutaneous injection of an extract of the thyroid; 3. The administration of the thyroid or its preparations by the mouth; 4. The administration of an extract of the thyroid by the rectum (Leichtenstern); 5. The inunction of a thyroid-lanolin cream (Menzies).

Since more convenient methods of administration of the thyroid were established, grafting has been given up entirely. The implanted thyroid sooner or later became absorbed, and the operation did not offer any advantage over the other more harmless methods of incorporating thyroid juice in the cachectic body.

The extract for the subcutaneous injection was prepared with glycerin and the addition of some carbolic acid or thymol. It has often produced abscesses, phlegmon, erysipelas, etc. A striking fact was observed that some cases which did not respond to the subcutaneous treatment have derived, nevertheless, great benefit from the administration of the thyroid by the mouth. The subcutaneous method also has been very little employed within the last few years.

The employment of the rectal and the inunction methods seems to have been entirely restricted to their originators, and we are not in a position to judge whether these methods render any reliable results.

Practically, then, we possess at present only one method of incorporating the thyroid in the body, and that is the administration of the gland or its preparation by the mouth. Of the particulars of this method we shall speak later.

The effect of the thyroid upon myxœdema is a wonderful one (compare Figs. 116–118). Twenty-four hours after having taken a small dose of thyroid the patients claim to feel improved. They are in better spirits and do not feel the swelling in their face in the morning on rising. After five or six days everybody can notice that the œdema is commencing to disappear, and the entire behavior of the patient undergoes a change. In a few weeks the change is so complete that often even intimate friends do not recognize the patient again. The most striking feature is, of course, the loss of the œdema, which leads to a considerable reduction of the patient's weight. In my case[29] of myxœdema the loss was nearly 50 lb. (see Fig. 118). The œdema disappears first in the upper part of the body. The skin becomes loose and baggy. With the disappearance of the œdema of the eyelids, the cheeks, the nose, and the lips, the patient loses the "cretinoid" appearance. With the disappearance of the œdema of the neck one can establish the absence of the thyroid gland. By the reduction in the size of the tongue and by the other changes in the nose, mouth, and

throat the voice attains a normal sound. The skin peels off in larger and finer scales, and becomes smooth and soft. It often becomes

Fig. 117.

Mrs. N., Jan. 17, 1894, after eight weeks' treatment with thyroid.

Fig. 118.

Mrs. N., Feb. 24, 1894, after three months' treatment with thyroid.

covered with a fine lanugo which soon disappears again. A crop of fine hair develops on the head, axilla, and pubes. The new hair is mostly of another color than that of the old. The temperature of the patient goes up, the frequency of the pulse increases, the patient feels warm. Perspiration sets in again, and sometimes even becomes profuse. The amount of urine is generally increased; the albumin, if there has been any, is decreased or totally absent. The movements of the bowels become regular. Menstruation and sexual instincts turn into a normal course. The change in the mental condition of the patient is nearly as striking as the external transformation of the body. Instead of the hallucinations, mental sluggishness, and irritability of temper, the patient becomes sound of mind, active, and in good spirits.

All these favorable changes take place also in fully developed cases of *cachexia strumipriva*, when subjected to the thyroid treatment. If the thyroid is administered soon after the total extirpation of a goitre none of the symptoms of cachexia make their appearance. Surgeons now very rarely remove the entire gland, since the detrimental effect of the total extirpation of the thyroid gland has become known. However, even after leaving a part of the goitrous thyroid, cachexia

might develop, as nobody is capable of judging whether the part left contains enough of the normal gland-tissue to meet the requirements of the body.

As to the results of the thyroid treatment of cretinism, the favorable results are also striking, but are not so plain as in the myxœdema of the adult. Besides the favorable effect upon the myxœdematous tissues we observe an unmistakable influence upon the arrested growth, especially the growth of the bones. The influence upon certain symptoms of the nervous system can be noticed quite early. The clonic convulsions and epileptiform fits in my case,[30] which used to appear every few minutes, disappeared twenty-four hours after the first administration of a thyroid preparation. It is also quite certain that the mental faculties are favorably influenced to a remarkable degree; the extent of the improvement, however, varies greatly; while the change in some of the patients is surprisingly complete, there being hardly any difference between them and normal children, we meet with some disappointments in other cases; though, to be sure, they are no longer cretins, yet their mental capacity is not much above idiocy. Even with regard to their external appearance cretins show a greater tendency than myxœdema patients to become bulky again, even during the treatment, by the acquirement of normal adipose tissue.

The brilliant success of the thyroid-therapy has, however, some drawbacks. When the administration of the thyroid is discontinued, all the old symptoms gradually reappear one by one. Therefore, to keep our patients in a healthy state, we must give them all their life long a larger or smaller quantity of thyroid.

Again, the thyroid is by no means a harmless remedy. Overdosing with thyroid produces a number of more or less serious symptoms, the entire complex of which is now known under the term of thyroidism. Certain symptoms of a disagreeable, but of a less serious and of a passing character are nearly constant companions of the administration of the thyroid. Ten or fourteen days after the institution of the treatment, even with moderate doses, the patient complains of an occipital headache, of "rheumatic" pains all over the body, of a tremor, and of general weakness. But these ailments are comparatively easy to remedy and usually soon pass by. Sometimes, however, there arise more serious and more persistent complications. Gastric trouble sets in, with persistent vomiting and profuse diarrhœa. Foulis[31] reported the death of a patient due to this condition. Sometimes tachycardiac attacks of quite a dangerous nature arise. The pulse goes up to 140 or even 180, becomes thready, the patient becomes dyspnœic, feels extremely oppressed, and looks ghastly. Sometimes an increase of the temperature is present. Indeed in a few cases these attacks terminated fatally. However,

these fatal results occurred only at an early stage of the new era, before the character of the remedy was well known; at present we no longer hear of such grave occurrences. Finally, some cutaneous disorders of a stubborn and annoying character, like urticaria, erythema, and eczema, have often accompanied the thyroid treatment. Sometimes sugar or albumin appears in the urine. It is probable that many of these symptoms are not to be considered as effects of the curative principle of the thyroid; they do not constitute the symptoms of thyroidism proper. The gland consists of proteid matter in the decomposition of which ptomaïnes and leucomaïnes are found; we may well assume that many of the alarming symptoms are due to the ingestion of these poisonous substances (Lanz,[32] Cunningham[33]). However, it is not to be denied that the effective principle itself might, when given in excess of the necessary neutralization of the element of the cachexia, affect in an abnormal degree the metabolism and the regulation of the nervous system in a manner opposite to the *cachexia thyreopriva*—athyreosis and hyperthyreosis. However this may be, our practical interest centres in these two points: 1. These complications soon disappear after discontinuance of the administration of the thyroid. 2. When the thyroid preparations are carefully selected and the dosage is carefully guarded, most of the untoward symptoms can be well avoided.

The thyroid can be given by the mouth either in the natural state, finely minced, raw, or slightly cooked; or in glycerin-extracts; or the entire thyroid is converted into a dried powder which is dispensed in capsules, tablets, or pills. Or, finally, the gland is reduced by a complicated chemical process to a substance free of albuminous matter, and then thoroughly mixed with sugar of milk, and dispensed in powders, tablets, or capsules—the iodothyrine of Baumann.

The administration of the unprepared thyroid has not been and will not be in extensive use. Even when slightly cooked it remains a disgusting article of food, and a thorough cooking might after all destroy the effective principle of the gland. Besides, if the obtaining of the thyroid from the animal be left to the patients or to the butcher, it will often happen that instead of the thyroid the submaxillary or the thymus gland will be taken; many instances of reported failures have been due to this mistake. However, it must be admitted that the ingestion of the entire fresh gland would be an ideal method, as thus the gland will surely contain all the effective parts of the thyroid without any of its decomposed proteids. The disgusting taste could be partly overcome by advising the patient to wrap the minced gland in a wafer. The glycerin-extracts of the thyroid have been in use more extensively than the fresh glands, though surely with fewer good results. The extracts always contain more or less decomposed

albuminous matter, and probably do not contain some good parts of the curative principle which, like the thyreo-iodine of Baumann, are not soluble in glycerin. The form which has come to be most extensively used is that of the dried and powdered gland dispensed in capsules, tablets, or pills. The success is without doubt due mainly to the convenience with which it can be obtained and dispensed; otherwise this form more than any other contains many decomposed proteids which some time assert their presence by an odor not to be disguised by a coat of sugar or gelatin. The desiccated powder and the tablet made from it are at present manufactured by many wholesale firms all over the world; we cannot give a full list of the brands. The tablets of Burroughs, Welcome & Co. of London have attained great renown in all parts of the world. Besides these tablets, we have in our own market the powder and tablets of the well-known firm of Parke, Davis & Co. and of Armour & Co. All these preparations are made from the sheep's thyroid, though the thyroids of other animals (ox, calf, swine, etc.) prove to be effective. Each tablet of Burroughs, Welcome & Co. is equal to five grains of the fresh thyroid. Two grains of the powder of Parke, Davis & Co. are equal to five grains of the fresh gland, the average weight of an entire thyroid of a sheep being estimated to be about twenty-four grains. Twelve grains of the powder of Armour & Co. are equal to an entire gland; one tablet contains two grains of their powder. I have obtained favorable results with the preparations of all the three firms, and I have also employed Thyroiden (Knoll) with considerable satisfaction.

The treatment should be started with small doses. One capsule (or a part of a tablet) containing powder corresponding to two grains of the fresh gland is sufficient to begin with. For the following few days there might be a daily increase of one grain. When the dose of six or eight grains is reached, it is better not to increase any more for a while and to watch the result achieved by these daily doses. If in a few days no unpleasant symptom makes its appearance, the increase with one grain a day can be resumed, continuing it for three or four days, then to be followed by another and longer intermission. If the patient is still not showing any untoward symptoms the increase might be again resumed. However, 15 grains a day should be the final maximum even when the patient shows a great tolerance for the remedy. When large doses are given it is better to dispense them in two or three parts than in a single dose. It is true that a single large dose seems to have a more immediate effect than the same amount given several times in smaller doses, but it is the large dose which also brings out the alarming attacks. When occipital headaches, pains in the body, or urticaria set in, the increase should be discontinued and a decrease of two or three grains in the daily dose should

be made. Phenacetin will remedy the headache, salicylate of sodium relieves the general pains, and a few small doses of pilocarpine drive away the urticaria. If, however, more serious symptoms appear, if the vomiting or diarrhœa or a very frequent pulse set in, the administration of the thyroid must be at once discontinued, the patient put to bed, and the individual symptoms as well as the general constitutional condition of the patient should be carefully watched and treated. The intermission should last at least eight to ten days, and when the treatment is again resumed the patient must be kept on only small doses of the thyroid for the next two or three weeks.

When the patient is undergoing an energetic thyroid treatment the diet should consist mainly of milk and vegetables; a meat diet seems to facilitate the outbreak of the more dangerous symptoms of thyroidism. The patient should be also guarded against too much exertion, and should be given strychnine ($\frac{1}{20}$ of a grain) three times a day.

If the thyroid treatment be carried out with conservatism, patience, and caution, no unfavorable effects are to be feared, and the good results are sure to come.

It was stated above that to maintain our athyreotic patients in a favorable condition they have continually to be treated by the administration of the thyroid. We must, however, distinguish between the treatment required to combat the myxœdematous cachexia already present and that adopted for the purpose of preventing a recurrence of cachexia. As soon as the condition of our patient is reduced to a state which would seem to be about normal the large doses of the thyroid are to be discontinued. All agree upon this, and also upon the further fact that the patient requires a continual after-treatment with smaller doses of thyroid. But there are as yet no definite rules as to how to proceed with these small doses. Some writers seem inclined to continue giving very small doses every day—just an imitation of the normal function of the thyroid; others give a somewhat larger dose once in three or four days; some give once a week, and some others speak even of once in a few weeks. In fact, while we have quite numerous detailed reports of success in the treatment of myxœdema, we have very few reports telling us of the further course the disease has taken during a longer period after a "cure" has been effected.

The statement which I am going to make here is mainly derived from my own experience: No matter which method we may employ, it will not prevent the earlier or later reappearance of well-marked symptoms of the cachexia. If small doses are given daily the recurrence comes quite early; soon the doses are to be increased, and the increase is to be kept on until a period is reached when even such doses as were maximum at the initial treatment are not sufficient

to exert the desired influence. When a larger dose is given once a week the recurrence of pronounced symptoms is distinctly delayed, but only delayed, the recurrence is bound to come, and what is worse, the preparation we employ fails to produce any further effect.

After some experimenting I adopted the following procedure: At first I gave a dose of 10 to 12 grains three or four times a week for three or four weeks. Then I discontinue the treatment for some weeks entirely, with the avowed purpose of letting some of the symptoms of the cachexia come on again. Now, even such small doses as 3 grains three times a day are sufficient to reduce within a week most of the unpleasant symptoms. After continuing this treatment for one week more I go back again to three times a week, and so on. The increase of weight I do not consider as a symptom of relapse, as some cases after losing their myxœdematous tissue are apt to increase in weight by acquiring healthy adipose tissue. I look upon the sensation of cold and the loss of the ability to perspire as sufficient evidence of the recurring onset of myxœdema.

The recurrence of these symptoms I have seen take place before any of the mental or other disagreeable features set in; the patient, therefore, suffers little by allowing some of the symptoms to reappear. In contrast with the normal function of the thyroid, the body seems to become less responsive to the daily artificial introductions of the thyroid, while susceptibility seems to develop when the body is subjected for some time to the thyroid inanition. In connection with the difficulties thus spoken of the following statement is of practical importance: If a preparation which was employed for some time fails to elicit any further effect, it should be put aside and a preparation from another source should be given, and the success is again assured; later on, the first preparation can again be administered with the original favorable effect. This somewhat surprising statement comes from several independent sources and I can confirm it from my own experience.

Iodothyrine.—A few years ago Baumann[34] discovered the presence of iodine in the thyroid gland. He succeeded in separating the iodine-bearing substance from the gland by a series of chemical procedures. This substance is insoluble in water, alcohol, acids, etc., is free from albuminous matter, and contains phosphorus in a very small quantity, while the iodine in this substance amounts to nearly 10 per cent. To this substance the name of "thyreo-iodine" was first given; it is now manufactured on a large scale at the well-known Farben-fabrik of F. Bayer & Co., Elberfeld, Germany, and is in the market under the name of "iodothyrine." The substance is now mixed with sugar of milk and arranged so that 15 grains (1 gramme) of the powder are about equal to 15 grains of the fresh gland and

that 15 grains of the powder contain $\frac{1}{120}$ grain (0.3 of a milligramme) of the iodine. Baumann and Roos have tested the effect of this substance upon the cachexia thyreopriva of dogs (and upon human goitres) and obtained the same favorable results as from the feeding of the gland-substance itself. Their statements were confirmed by other experimenters. The efficacy of iodothyrine has been tested in human beings on cases of myxœdema, goitre, and obesity.

I have used iodothyrine for some time; the results are quite satisfactory, but they differ in some respects from those seen after the administration of the gland-substance itself. After permitting a myxœdema patient to develop distinct cachectic symptoms, including mental manifestations and development of some myxœdematous tissue, I placed her upon the treatment with iodothyrine. I started with 5 grains three times a day and had it increased within two weeks to 30 grains a day. All the symptoms of the cachexia gradually subsided, but the improvement took place quite slowly, much slower than when administering any of the other preparations. As stated above, 15 grains of iodothyrine are about equal to 15 grains of fresh gland. When I administered from the other preparations the quantity equal to 15 grains of the fresh gland, the subsidence of the symptoms went on quite rapidly and was more pronounced than after giving for some time 30 grains a day of iodothyrine. But, on the other hand, with the other preparations I hardly ever could overstep the limit of 15 grains without being halted by serious complications; with the iodothyrine, however, even after taking 30 grains a day for a number of weeks the patient did not experience any unpleasant symptoms whatsoever.

Baumann claimed that iodothyrine contains the entire anti-cachectic principle which is present in the entire gland. A striking point against this view, however, is the fact that curative results were originally obtained by alcoholic and glycerin extracts. As iodothyrine is insoluble in alcohol and glycerin, these extracts did not contain Baumann's substance, nevertheless it is just these extracts which have inaugurated the thyroid-therapy.

It seems to me that there can be no doubt that the iodothyrine represents only a part of the effective substance of the thyroid. Nevertheless I would strongly advocate its employment. It does not contain albuminous matter, it does not contain toxins and ptomaïnes, and it does not decompose at all; even after months there is no odor or any other sign of decomposition. Therefore, perhaps, the iodothyrine does not cause so often those disagreeable symptoms which are unavoidable when the other preparations are used in efficient doses. The only trouble with this preparation, at least for the present, is its high price.

According to Robert Hutchison[1] the active principle of the thyroid gland is to be found exclusively in its specific secretion, the colloid substance. He describes a method for obtaining it in a pure state. It is claimed by Hutchison and others that the administration of the colloid brings out as good results as can be obtained by the administration of the entire gland.

Goitre.

The hypertrophy, or more correctly the enlargement, of the thyroid gland is termed goitre. This diseased condition is either congenital or acquired. In the latter case the development is either acute or chronic. We have to distinguish between sporadic and endemic goitre. Sporadic cases of goitre are evenly distributed all over the world, but they are comparatively rare. The endemic goitre is confined to certain regions, of which the central Alps in Europe are a striking example. In the goitrous districts which are to be found in all parts of the world this disease is quite of frequent occurrence, and plays quite an important part in the life of the population. There are on record also epidemics of goitres occurring even in regions where the goitre is not endemic.

Mechanical effects have something to do with the causation of the sporadic goitre. It develops during pregnancy or parturition, it may come after trauma, the development is influenced by all movements which produce hyperæmia of the thyroid: constant work with the head down, cornet-playing, etc., emphysema, valvular heart trouble, etc.; but it is very doubtful, to say the least, whether these mechanical factors are the sole cause of the development even of the sporadic goitre.

As to the origin of the endemic goitre many theories have been advanced. St. Lager[35] enumerated more than forty. There seems to be at present unanimity of opinion on one point—namely, that the drinking-water contains the evil factor. There is quite a divergence of opinion, however, as to what this factor may be. Some connect it with the difference in the geological strata with which the water comes in contact; some accuse the presence, some the absence, of certain inorganic substances in the water. Others think of organic substances, and still others of specific germs, of bacteria. We mention these theories inasmuch as they have some bearing upon certain prophylactic measures.

Goitre occurs in women more frequently than in men. Heredity is a recognized factor. The goitre is either unilateral, when mostly the right lobe is affected, or it extends over both lobes; it also starts

[1] *Brit. Med. Journal*, June 23, 1897.

sometimes from the isthmus. Usually it is located in front of the neck; in some cases, however, the location of the goitre is subclavicular or substernal, or it is wandering—*i. e.* it is sometimes within and sometimes outside of the anterior mediastinum. The goitre can also sometimes be submaxillar, retro-pharyngeal, or retro-tracheal.

With regard to the differences in the structure of the enlarged thyroid gland, the goitre is divided into many forms, the knowledge of which is of practical importance. In a parenchymatous or follicular goitre the enlargement is due to the increase in the number of the follicles. If the follicles themselves are degenerated and contain a large amount of colloid, the enlargement is termed colloid goitre. In a cystic goitre the walls between many enlarged follicles are atrophied, and the follicles form together one large cyst which may contain colloid material, serum, or blood. A cystic goitre may contain one or many such cysts. The hypertrophy of the interglandular connective tissue is the pathological basis of a fibrous goitre. Finally, in a vascular goitre the blood-vessels are dilated. In many cases all of these changes are to be found in one and the same goitre. In many cases of goitre the course is slow and the patients are but little affected by the disease. In other cases, however, the goitre is the source of serious troubles, and the patient is constantly in danger. The pressure upon the soft trachea and upon the recurrent laryngeal nerves causes chronic dyspnœa and sometimes sudden asphyxia and death; the pressure upon the sympathetic often causes headache, and the pressure upon the pneumogastric or accelerating nerves causes tachycardia and palpitation.

Treatment.

Children of goitrous parents should be removed from the goitrous district. The same applies to the goitrous people themselves, as there are cases on record where goitre disappeared after the patients removed to another locality. Even entire epidemics were suppressed by this method (see Ewald). Improvements in the general sanitary condition have a favorable prophylactic effect upon the development of the goitre. The hygienic condition of the individual has also something to do with the acquisition of the goitre. The water should be filtered and boiled, or, still better, rain-water or water conducted from another non-goitrous region should be used.

Acute sporadic cases often disappear spontaneously without further treatment.

The treatment of goitre can be either medical or surgical. The medical treatment consists in external applications, in intraglandular injections, and in internal administration of medicines. The drug which hitherto has been mostly employed and has given the most

satisfactory results is iodine. For external applications on the goitre have been used either the plain tincture, or iodine and potassium iodide in solution (iodine 1, potassium iodide 5, water 100), or iodide of potassium or iodoform-salve with lanolin. Also mercurial preparations have been employed for external use. There are many statements with regard to favorable results achieved by this method. Personally, I have seen no influence whatsoever from these external applications. We might mention here also the claim that cataphoresis (with iodine) effected a cure; also that the galvanic current (60 milliampères) is recommended in goitre.

The intraglandular injections are made by first inserting the needle of a hypodermic syringe, and when blood is not coming the syringe is attached and the fluid injected, thus preventing the dangerous injection into a blood-vessel. Tincture of iodine is mostly employed: 10 to 15 drops every few days until ten to twenty injections are made. Good results were obtained in parenchymatous goitres; some claim a certain improvement also for fibrous and cystic goitres. There is a positive contraindication to employing this method in colloid and vascular goitres. Mosetig v. Moorhof recommended iodoform (iodoform 1, ether 5, olive oil 9; the mixture not to be exposed to sunlight). Injections were also made with perchloride of iron, alcohol, Fowler's solution, osmic acid, ergotin, carbolic acid, etc. It seems to be the general opinion that all these remedies are not by any means so effective as iodine, and on the other hand are a good deal more dangerous. We must state, however, that there are on record about thirty deaths following the injection of iodine into the goitrous mass. In view of this fact, and in view of the fact that we now possess remedies and methods at least as reliable as the intraglandular injection, this method should be entirely discarded.

Administration of potassium iodide internally has unquestionably accomplished in very many cases a reduction of the goitre; 10 to 15 grains a day is a sufficient dose. Also other preparations of iodine were given, like iodide of iron, iodoform ($\frac{2}{3}$ of a grain three times a day in pills), spongia usta, etc. However, the administration of iodine has also a drawback. It sometimes produces a complex of symptoms which has been termed *iodism*. The patient became thinner, had palpitation, felt sick, and sometimes even had fever. These symptoms used to appear soon after taking small doses, when there was a rapid decrease in the goitre. There is at present a general inclination to consider iodism as a sort of cachexia strumipriva, under the assumption that the iodine has reduced also the normal gland to an ineffective minimum. It seems to me, however, that the symptoms of iodism remind one rather of Graves' disease than of myxœdema. We should note here that according to Woakes [36] hydro-

fluoric acid (20 to 25 minims of a $\frac{1}{2}$ per cent. solution) has proven to be very effective even in cases which did not respond to the treatment with iodine.

The Treatment of Goitre by Thyroid.—While studying the effect of thyroid-feeding upon insanity, Reinhold[37] made the accidental observation that in goitrous patients during the administration of the thyroid the goitre became distinctly smaller. Soon after, Bruns[38] started a systematic treatment of the goitre with thyroid and obtained very favorable results. There are already numerous reports confirming the statements of Reinhold and Bruns, and the successful treatment of goitre with the thyroid gland can safely be considered as a well-founded fact. From my personal experience I would say that the treatment of the goitre with products of the thyroid brings about decidedly better results than the treatment with iodine. The method of administration is the same as in myxœdema, only that the increase in the doses can be pushed much farther and more rapidly. There is a limit to the administration of the thyroid, also, in the treatment of goitre—large doses will finally produce thyroidism; but goitrous persons seem to stand the ingestion of thyroid better than do myxœdematous patients, also the symptoms seem not to become so grave, and they disappear soon after the discontinuation of the thyroid-feeding. The goitre seems to share, however, the fate of myxœdema as far the relapse is concerned. There are so far only a few cases on record with an absolute cure, and besides the period of observation is as yet too short to enable us to form a positive opinion. The form of enlarged gland which benefits mostly by the thyroid treatment is the parenchymatous goitre; however, even the fibrous, colloid, and cystic goitres benefit greatly by the treatment, inasmuch as nearly all the goitres contain some soft tissue which is absorbed and by which the goitre becomes smaller and the adenomata or cysts become more distinct and more amenable to surgical treatment. The subjective symptoms, especially the dyspnœa, seem to improve soon after the administration of one or two doses and long before the decrease of the goitre can be noticed. I can further report that iodothyrine also effects a reduction in the size of the goitre; but here, too, as in myxœdema, the effect is much slower than the one produced by the ingestion of the preparations which contain the substance of the entire gland.

Treatment of Goitre by the Thymus Gland.—Mikulicz[39] has reported that the use of the thymus gland produced similar results to those attained by using the thyroid gland. His experience was derived from the treatment of 10 cases. Reinbach[40] has followed him with a report of 30 cases, 20 of which were positively improved. The improvement is just as marked as that effected by the treatment

with thyroid, and in some cases the thymus brought relief where the previous treatment with thyroid did not yield any result. The main advantage of the administration of the thymus gland consists, however, in the fact that it can be given in large doses and for a long time without producing any untoward symptom. I can emphatically confirm this statement, as patients of mine have been taking large doses of raw thymus from the lamb every day for more than a year without having any unpleasant symptom whatever. Mikulicz and Reinbach employ mostly fresh, raw glands finely minced. They start with 10 to 15 grammes ($\frac{1}{2}$ to $\frac{2}{3}$ oz.) three times a week, and increase the dose even to 30 grammes (1 oz.), though they do not believe that the larger doses effect better results. There are in the market a powder and tablets of thymus. There is, however, less trouble in obtaining fresh thymus than thyroid glands, as the butchers well know the former and do not know the latter.

The surgical treatment of the goitre lies outside of the scope of this chapter, and we shall therefore restrict our reference to this method of treatment to only a few remarks. Excision of the entire gland is not now practised; usually about one-fourth is left in order to prevent the development of the post-operative myxœdema. This part, however, might not contain sufficient normal tissue, and it is therefore advisable to start with some thyroid-feeding in order to prevent a possible tetanic outbreak. Thyroid-feeding should also precede the operation, for the purpose of bringing out more clearly the cysts or adenomata. Angerer, however, believes that this previous feeding with thyroid was the cause of a death which soon followed the thyroidectomy, the assumption being made that the thyroid-feeding had a weakening influence upon the heart. There cannot be such an objection to the administration of the thymus, if the statements of Mikulicz and Reinbach are generally confirmed.

There are at present many operative measures which have their indications according to the special requirements: Division of the isthmus to relieve tracheal pressure; incision and drainage of cysts; enucleation of cysts, adenomata, etc.; partial resection of fibrous goitres, and the ligation of the thyroid arteries, especially in vascular goitres. Ligation of all the arteries is not, however, now practised, as it is found to produce a cachexia similar to that which appears after total removal of the goitrous gland.

Other diseases of the thyroid and their treatment do not require an extensive description.

Hyperœmia occurs during menstruation, pregnancy, parturition, or may be due to any pathological course which offers a resistance to the return of the venous blood from the neck (mediastinal tumor, valvular

heart trouble, emphysema). The treatment is directed as far as possible against the primary cause. Some simple hygienic measures, like the avoidance of a tight corset, a tight collar, of sitting with the head bent forward, of climbing stairs, mountains, etc., are all that can be advised.

Thyroiditis is an inflammation of the thyroid which is either idiopathic or occurs as a sequel or complication or metastasis of many infectious diseases. It occurs also and even more often in a goitrous thyroid; it is then termed strumitis. There is a large, painful swelling over the region of the thyroid, and this is often accompanied by high fever and with chills. It lasts between a few days and a few weeks. The swelling either resolves or it forms one or more abscesses which, when left to themselves, will find their way either outside or into the mediastinum, trachea, etc. The treatment should consist, at least at the beginning, in cold applications in any form; perhaps leeches to the jugular region, inunction of iodoform-salve, and thorough evacuation of the bowels. Exploration with the aspirating needle has to be practised early, in order to detect the formation of an abscess, which must be evacuated and treated in accordance with surgical principles.

Tuberculosis of the thyroid gland is mostly secondary; its treatment is that of tuberculosis in general.

Syphilis of the thyroid is very rare; in one case it gave rise to development of myxœdema, which was subsequently cured by antisyphilitic treatment.

Echinococcus of the thyroid is also quite rare; it might be taken for a cystic goitre, but the aspiration will clear up the diagnosis. The treatment is incision and drainage or enucleation, if possible.

Actinomycosis of the thyroid occurred in one case. There were symptoms of myxœdema; the patient was cured by the resection of the infected part. Later, however, myxœdema reappeared and had to be treated by thyroid.

Sarcoma of the thyroid is more rare than *carcinoma;* both are met more often in goitrous regions and occur also more often in a goitrous than in a normal thyroid gland. It might be difficult to distinguish between a benign goitre and a malignant tumor. The goitre displaces the large blood-vessels; the malignant tumor embraces them, is adherent to the skin, and forms metastases in the neighboring lymphatic glands. In a case described by Treupel[41] the absence of the effect of iodothyrine upon the swelling was employed as a means for differential diagnosis. The treatment is quite hopeless. The operative removal is very difficult and the results are usually bad. Under these circumstances a trial should be given to

the toxins of the erysipelococcus (Coley [42]) or to the cancer-serum of Emmerich [43] and Scholl or of Richet and Héricourt.[44]

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Graves' or Basedow's Disease.

Exophthalmic goitre was described by Graves[1] in 1835 and by Basedow[2] in 1840. It is an established fact that the disease was seen first by C. H. Parry in 1786, and was described by him in a paper which was published, after his death, in 1825.[3] It would, therefore, be more correct to let the disease be known by the name of Parry—"Parry's disease."

The disease is generally known by its three striking symptoms—tachycardia, goitre, and exophthalmos. The eye shows other symptoms which are more or less peculiar to this disease: 1. The unnatural width of the palpebral fissure and the diminished frequency of the normal blinking: Stellwag's symptom.[4] 2. The upper lid does not follow the downward rotation of the eyeball: Von Graefe's sign.[5] Both signs are early symptoms and are often present before exophthalmos is developed; they are more constant symptoms of Graves' disease than the exophthalmos. 3. The insufficiency of convergence; a near point cannot be seen with both eyes at once: Moebius' sign.[6] There are sometimes present peculiar rapid vibrations of the eyeballs, and also all degrees of paresis, including complete ophthalmoplegia. The exophthalmos and all the other symptoms are mostly present in both eyes; in some cases, however, only one eye shows the abnormality. The exophthalmos can be of all degrees, and is sometimes, perhaps, so moderate as to be overlooked entirely. In the cases on record in

the literature the presence of exophthalmos is noted, as it seems, only in 80 per cent. All authors seem to agree that the exophthalmos is not essential for the diagnosis of Graves' disease.

The goitre, too, is in Graves' disease sometimes only unilateral, and then mostly on the right side. Until lately it was believed that the goitre in this disease was mostly of a vascular type. Recent anatomical investigations, however, have shown that a glandular degeneration is constantly present; F. Mueller[7] found this degeneration of the thyroid in a case of Graves' disease with no goitre. Also the cystic and fibrous forms of goitre are not so rare in this disease. The goitre either appears simultaneously with the symptoms of the disease or it develops later. There are cases where a goitre was present for some time before any of the other symptoms set in. They are the "secondary" cases of many authors. Buschan[8] considers such cases as pseudo-Graves' disease, though they may show all the other symptoms just as well as the "genuine" disease. As to the constancy, some authors have distinctly stated that in their cases a goitre was absent. Moebius,[9] however, distrusts this statement; the goitres might have been so small that they were overlooked.

With regard to the tachycardia, there is hardly a dissenting voice to the verdict of Charcot:[10] No tachycardia, no Graves' disease. In mild cases the pulse is about 100 per minute; in severe cases it can go up to 140–150 per minute, and sometimes even over 200 per minute. Besides the increase in frequency, the heart-beat is strong; there is palpitation, and this is often the first subjective symptom the patients complain of. There is sometimes present, temporarily or permanently, dilatation of the heart, which leads now and then also to hypertrophy. A systolic murmur is infrequent, and is usually associated with anæmia. Genuine valvular trouble, if present, is only a complication, not an essential part, of Graves' disease. There is a strong pulsation in all the arteries of the body, especially in the carotids and the abdominal aorta. In some cases a thrill can be perceived in the goitre (Fig. 119).

Outside of these cardinal symptoms there are a number of other symptoms which are met with quite often and are important for the diagnosis of the undeveloped forms of Graves' disease—*formes frustes*—and also for the prognosis of the disease. Charcot and Marie[11] have directed attention to a peculiar tremor which is present in nearly one-half of the cases. It is sometimes confined to one side and even only to one of the upper extremities. The tremor is to be distinguished from certain choreiform movements which are met with in some cases of Graves' disease (Kahler[12]). Diarrhœa is present in about one-half of the cases, and is sometimes the cause of the fatal outcome of the disease. It comes mostly in attacks recurring every few weeks.

Vomiting is infrequent, but also quite a serious symptom of the disease. There are present quite a number of vasomotor phenomena.

Fig. 119.

Exophthalmic goitre.

The patient blushes at the slightest provocation; feels a burning heat; has the *tache cérébrale;* urticaria; circumscribed œdema on all parts of the body.

There are many other symptoms: Pigmentation of the skin, reminding one of Addison's disease. Falling out of the hair on the pubes, eyebrows, etc. Profuse perspiration, which is the cause of the lessened resistance of the skin to the galvanic current: Vigouroux' sign (Chvostek,[13] Vigouroux[14]). Elevation of temperature, permanently or temporarily. Glycosuria, polyuria, polydipsia, and bulimia. The breathing capacity is diminished: Bryson's sign. General waste of the body and circumscribed atrophy of muscles; atrophy of the uterus. Manifold symptoms of nervous origin: Paresis and paralysis of certain groups of muscles, "the giving way of the legs," the irritability of temper, the insomnia, all forms of hysteria, and many forms of insanity.

The disease occurs more often in women than in men (nearly five to one). Some cases have presented a striking history of hereditary influence. Eight children and two generations with Graves' disease in one family (Oesterreicher[15]), also three consecutive generations with this disease (J. Rosenberg[16]). Some sorts of nervous diseases were found to exist in the families of nearly every case of Graves'

disease. It is claimed that the disease is more frequent along the sea-coast than inland, and that some races are more predisposed than others. As yet, however, there are no statistics for either of these claims. Among the incidental causes of the outbreak of the disease shock and fright seem to take the first place.

The onset is sometimes acute, but mostly gradual; the further course is nearly always chronic. Death occurred in 10–11 per cent. of all the cases, and is due either to some intercurrent accidental disease or to the heart or the intestinal trouble of the disease itself. Some cases have terminated in myxœdema.

The pathological anatomy of the disease is, except perhaps in the thyroid, nearly a blank. Changes in the sympathetic nerve, in the pneumogastric nerves, in the medulla oblongata, were recorded in some cases, but only in the minority and mostly by writers who had a theory to support. Those changes might have been artifacts or might occur even in normal bodies. Askanazy [1] described a lipomatous degeneration of all the muscle fibres which he found in four autopsies.

There are many theories with regard to the nature and origin of the disease: The sympathetic nerve is paralyzed or is irritated; the pneumogastric nerve is affected; both kinds of nerves are affected; the location is in the medulla oblongata with an anatomical basis, or a simple functional neurosis; the brain-cortex is responsible; it is a form of hysteria. It is due to an auto-intoxication.

The theory which stands at present in front of the discussion is that which assumes that Graves' disease is caused by "hyperthyreosis." Graves' disease shows a large number of symptoms which are diametrically opposite to those of myxœdema. This disease is due to the absence of the thyroid function—"athyreosis" or "dysthyreosis"—consequently Graves' disease is due to an abnormal increase of the function of thyroid: hyperthyreosis. Moebius [17] is the originator of this theory, which has many prominent followers also in this country, like James J. Putnam,[18] M. A. Starr,[19] and F. Kinnicut.[20] Many proofs are now being brought forward in support of this theory: The symptoms of myxœdema disappear when thyroid is administered; however, an overdose of the gland produces "thyroidism"—that is, a complex of symptoms which are similar, so it is claimed, to those present in Graves' disease. It has also been stated that in some cases of thyroidism in man even a goitre made its appearance (Notthaft [21]). Ballet and Enriques [22] reported that they had produced a goitre in a dog by subcutaneous injections of thyroid-extract.

[1] *Deutsches Archiv. für Klinishche Medizin*, Band vi.

Treatment.

The treatment of Graves' disease is to be considered under four heads, as follows: Hygienic, medicinal, electrical, and surgical treatment.

Hygienic Treatment.—Rest is in Graves' disease an indispensable measure. In acute cases or in acute aggravations in chronic cases the rest must be in bed and absolute. It prevents the progress of the disease and alleviates many of the symptoms. The tremor subsides, the heart-beats lessen in number, and the goitre and exophthalmos become appreciably smaller. During the course of chronic cases it should not be insisted upon that the patients stay in bed or go through the ordeal of a "rest cure," as this rather increases their irritability. They should be advised to rest a few hours every day, to avoid all exertions, prolonged and brisk walks and unnecessary climbing of stairs and heights. This does not apply to the systematic treatment by walking and climbing according to Oertel's method, which has its proper indications in some cardiac troubles, and which also was employed, it is claimed, with success in Graves' disease (Funkel [23]). Mental rest is also an important factor in the hygienic management of this disease. Excitement of all sorts (including sexual) should be avoided as much as possible.

As to the selection of a place of abode, life in the country is preferable to living in the city; the sea-shore is well recommended by many writers. Mountain air is highly praised by some and warned against by other authors. A moderate altitude is probably beneficial. Many recommend it with the view of having permanent quarters. It seems to me that an occasional change of scenery and places has rather a soothing effect upon the depressed patients.

Balneotherapy is probably not a very important factor in the hygiene of Graves' disease. Chalybeate and acidulous springs are recommended. Schott [24] speaks well of Nauheim, which is now in vogue for all cardiac derangements. Sea-bathing is warned against by many authors, though it has its advocates. I had a sad experience with sea-bathing: A patient of mine with all the characteristics of Graves' disease, especially with strongly pronounced tachycardia and vasomotor disturbances, was stopping at the sea-shore. She was then at her best. One day she experienced an irresistible longing to try a sea-bath, which she had not had for many years. She went into the water against the energetic protestations of her family. She had had her feet in the water only a minute or two when she suddenly fell back dead.

A much more important factor is the hydrotherapy. The authors are unanimous in the opinion that partial or total wet pack,

shower-douche, and other methods of hydrotherapy have proven to be beneficial in many cases of Graves' disease. Of course, the treatment has to be individualized according to the prevailing symptoms, preferring generally the more gentle methods of this therapeutic measure. The effects of the hydrotherapy can be assisted by judicous massage or mild applications of some of the methods of mechano-therapeutics. It is claimed that vibration of the ribs reduces strikingly the pulse-frequency (Winternitz[25]). We might mention here that some authors recommend a mild compression of the goitre or of the exophthalmos by mechanical appliances.

We should not omit to note that, according to some authors (Charcot, Buschan) pregnancy exerts a favorable influence upon Graves' disease.

Diet is another important point in the management of Graves' disease. With regard to the tendency to general waste of the body the patient has to be fed well, but with regard to the frequent occurrence of diarrhœa and vomiting the food has to be judiciously selected. Furthermore, the condition of the circulatory system requires the omission of alcoholic beverages, coffee, tea, tobacco, etc.

Von Hoesslin[26] reports the cure of a case of long standing by keeping the patient on a vegetable diet. W. H. Thomson[27] recently came out strongly in favor of an exclusive milk diet. This has already been advocated by v. Graefe, Friedreich, and others. Thomson thinks that Graves' disease is a state of auto-infection due to absorption of ptomaïnes from the gastro-intestinal canal. While it is, indeed, a generally acknowledged measure to restrict the meat diet in Graves' disease, the past has shown that the proposition to keep the patients on an exclusive milk diet has not acquired many adherents. However, in cases with gastro-intestinal complications Thomson's plan of treatment should receive a fair trial.

Medicinal Treatment.—Quinine had its day; we do not hear much of it now. Iron in any form was a favored remedy and is still greatly in use; but there are old and new statements to the effect that an aggravation of the symptoms often follows the use of iron. Digitalis is often prescribed, but it seems that in Graves' disease digitalis does not even reduce the number of heart-beats. The effect of strophanthus seems to be considered a little more favorable; at least there are as yet not as many writers denying its effect as is the case with digitalis. I have had no success with either. An ice-bag or the application of cold in any other form on the præcordial region has also in Graves' disease an indisputable quieting effect upon the rapidly beating heart. English and American writers praise the good effects of belladonna; it is given by the mouth or applied as a plaster on the præcordium or on the goitre.

Potassium iodide is recommended by some authors and discarded by others; it reduces the goitre, but increases the number of the heart-beats. It should be remembered that the administration of iodine in goitrous cases sometimes produces "iodism," a state which reminds us a good deal of Graves' disease. Bromides fulfil their mission—the patient becomes more quiet and finds sleep. The following drugs—arsenic, strychnine, picrotoxin, ergot, nitroglycerin, nitrate of silver, etc.—have been recommended by one or another author as useful remedies in Graves' disease. The statements of the cures which have been effected by all these drugs can only serve as a proof that Graves' disease often gets better not only without but even in spite of certain treatments.

W. H. Thomson (see above) lays stress on the unremitting use of what he calls intestinal antiseptics. Two grains of calomel about once a week and the frequent use of phenol bismuth, naphthol bismuth, bismuth subcarbonate or salicylate, salol, ichthyol, etc. Of course, this is in conformity with his theory that Graves' disease is an auto-infection of intestinal origin.

Kocher[29] has lately introduced a remedy in the treatment of Graves' disease which was suggested to him by v. Trachewsky. It is the plain sodium phosphate given in quite large doses (2–10 grammes daily). Sahli and Kocher have obtained good results with this remedy; so have also Edes,[30] Starr,[19] and Moebius.[31] I shall verbally quote the latter's statement; it is quite instructive: "The inventor assumed that goitre in Graves' disease is caused by a diseased condition of the medulla oblongata. Semmola recommended sodium phosphate for diabetes: diabetes is a disease of the medulla: consequently, etc. In spite of this strange deduction I made up my mind to test this remedy, and to my astonishment the patients were well satisfied with it; they slept better and became quieter. Some thought they liked the new remedy better than the bromide powders." This shows that even poor theories are capable of bringing out useful facts.

The effects of the thyroid upon Graves' disease were tried in a good many cases. The majority of the writers state that it has a deleterious effect; but there are some authors who claim to have seen an improvement, and in a few cases even a cure of the diseases, by the administration of this gland. From the standpoint of the "hyperthyreosis theory" this seems to be unexplainable. My personal experience coincides with that of the majority. Only a few grains of the thyroid were sufficient to produce a pronounced distress; tachycardia, tremor, vasomotor symptoms became markedly increased, and the patient begged to discontinue the remedy.

One of the cases of Graves' disease which figure as being cured

by the thyroid treatment was that of D. Owen.[32] This author discovered later, however, that his patient had all along taken the thymus instead of the thyroid gland. Thereupon the thymus was employed intentionally for this disease, by Owen himself, by Cunningham,[33] and by Mikulicz,[34] with favorable results. The doses are the same as given in Goitre (which see).

Lauder Brunton and others recommended lately the administration of suprarenal extract in Graves' disease. H. Mackenzie[34] has no confidence in the therapeutic value of the thymus, and he and Ord[35] express their doubts also regarding the usefulness of sodium phosphate in exophthalmic goitre. I have had experience with both drugs and I decidedly disagree with these authors. I have employed both drugs in every case of Graves' disease which came under my hands within the last three years, and I never failed to notice a distinct improvement. One case which has been under my observation for the last twelve years and which, until three years ago, in spite of all medication, became steadily worse, is now, thanks to these drugs, permanently cured since two years. The patient had for ten months every day thymus (raw, minced in wafers) and sodium phosphate (4 grammes 3 times), and for six months longer sodium phosphate alone. Tremor, diarrhœa, vasomotor disturbances improved early, then the reduction in the exophthalmos and goitre followed; the tachycardia was the last to improve. The pulse, which used to fluctuate between 130 and 160, is now about 72 and steady. Only a small hard nodule remained of the former large goitre.

I have made more extensive use of sodium phosphate than of the thymus, and I can state regarding the former that it is a very valuable drug in the many incomplete forms of Graves' disease: tachycardia, vasomotor anomalies, tremor, etc., are unmistakably influenced by its administration. I have seen a large parenchymatous goitre distinctly decreasing with the administration and increasing with the omission of the drug.

Electricity.—The nervous symptoms and the prevailing theories of the nervous origin of Graves' disease early suggested the use of electricity as a therapeutic measure in this disease. The galvanic current has been and is still in use. As to the mode of application there is quite a variety of methods. One proposes to galvanize the cervical medulla, the other the sympathetic nerve, the heart, the goitre, and even the exophthalmos. The strength of the current employed has been usually not more than a few milliampères. Lately, however, there is an increasing tendency to employ stronger currents, and Rockwell,[36] who has seen in many cases very good results from his method, used in some cases as strong a current as 60 milliampères. Vigouroux[37] recommends highly the faradic current too, and Eulen-

burg[38] speaks favorably of Franklinisation and of electric baths. The unanimity with regard to the favorable effects of electricity in Graves' disease is, however, restricted to the use of the galvanic current. Moebius, who admits the favorable influence of electricity, believes, however, that this is only due to suggestion. *A propos* of suggestion, Audry[39] reports the case of a woman with Graves' disease complicated by hysteria, who became cured after she was made to believe that she had been operated upon; and Brandenburg[40] speaks of a case of Graves' disease which became better in Lourdes.

Surgical Treatment.—The first operation upon the goitre in Graves' disease was performed by Tillaux[41] in 1880. It was thought at that time that he would have very few followers. However, we have at present on record more than 200 cases of surgical treatment of our disease. The main increase falls on the last few years, as can be seen from the following data: Mannheimer[42] had collected, in 1894, 42 cases; A. Heydenreich,[43] in 1895, 61 cases; Buschan,[44] about the same time, 80 cases, and in April, 1896, F. Kinnicutt[45] collected 187, and M. A. Starr[46] 190 cases. I have the impression that the results attained by the numerous operations tend to discourage their too frequent application in cases of characteristic Graves' disease. In the 190 cases collected by Starr there were 23 deaths due to the operation alone, which makes a little more than 12 per cent. mortality. This is a little higher than the average mortality of Graves' disease. While these operations, to say the least, did not improve the average mortality of the disease, they shortened life in 23 of the patients. Furthermore, there has hardly been an operation with a successful result which was not reported, while I am sure that many a fatal operation was performed which was not brought to record. I have personal knowledge of three fatal cases which are not recorded. There is quite a striking contrast between the results of the operations upon the plain goitre and those upon the goitre of Graves' disease, and some writers believe that the cases with favorable results belong to the secondary form of Graves' disease, with goitre as a primary cause or at least a primary symptom. It seems that in some cases, at least, soon after the operation on goitre in Graves' disease a peculiar, mysterious process takes place. Even when the operation is performed with extreme care and with scrupulous asepsis, soon afterward the temperature of the patient becomes very high, and the pulse reaches 200 per minute.

Some writers try to explain the peculiar phenomena by assuming that the operation causes in some way or other a great flow of "thyroidin" by which the entire body becomes intoxicated. These facts show us the necessity of keeping our hands away from the thyroid gland unless there is an imperative indication for an immediate

surgical interference. As to the method, Kocher considers the ligation of the thyroid arteries (only three) as the best one to be employed in operating upon the goitre in Graves' disease. Other surgeons, however, employ mostly resection. Poncet employs his new operative method of *exo-thyreopexie*, that is, the simple exposure of the thyroid gland. It would seem that this ought to be quite a harmless procedure, nevertheless Poncet lost one patient a few hours after the operation in the peculiar manner described above.

Jabaulay[47] and many other French surgeons are practising lately resection of the cervical sympathetic in cases of exophthalmic goitre, and report gradual improvement of all the symptoms and even permanent cures.

We should record here the statements of Hack,[48] B. Fränkel,[49] and others claiming that cases of genuine Graves' disease have been cured by local nasal treatment. Also the removal of a polypus of the uterus was sufficient, it is claimed, to "cure" a case of Graves' disease. Venesection in Graves' disease is a surgical measure of the past.

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DISEASES OF THE THYMUS GLAND.

THE thymus gland is situated in the upper part of the anterior mediastinum. It grows only during the first two years of life and remains stationary until about puberty, then as a rule it gradually degenerates, though there are exceptions of a persistent thymus. It is considered as a "ductless gland," though there is no secretion and the tissue is more of an adenoid character. With regard to the pathology of this gland there is not a single point which can be considered as settled. Cases of exudation and suppurative inflammation of the thymus were described, also tuberculosis, syphilis, and malignant tumors of the gland are mentioned. Such cases are at any rate very rare and surely secondary to some primary foci. There is no reliable symptom by which a positive diagnosis of any of these diseases could be made *intra vitam*. Even at the post-mortem some writers were unable to distinguish between an abscess and normal degeneration of the thymus, or between a swelling of the gland or a cluster of swollen lymphatic glands. Laryngismus stridulus has been in former years ascribed to the swelling of the thymus gland; Friedleben[1] denied such a relation. Lately, however, we find again some authors

connecting certain deaths of children under symptoms of spasmus glottidis with the hypertrophy of the thymus (Jacobi,[2] Biedert,[3] Pott,[4] Grawitz,[5] etc). Forensic medicine has cases of sudden deaths of adults on record in which an enlarged persistent thymus was found (Kob,[6] Seydel[7]). Such enlarged persistent thymus glands were also found in cases of sudden death while in the water (A. Nordmann[8]). The usual explanation of the connection between the enlargement of the thymus and the sudden death is to the effect that the enlarged gland is mechanically compressing the trachea and the nerves passing through the narrow aperture of the thorax. Other writers, however, see in the enlargement of the thymus gland only a part of a "status lymphaticus" (Paltauf,[9] Escherich[10]).

We will do no harm to our patients if we admit the possibility that an enlarged thymus is sometimes the sole or a contributing cause of a dyspnœa, especially when the percussion of the upper part of the sternum reveals dulness. In such cases the application of an ice-bag over the sternum or of leeches to the jugulum, or the administration of a purgative might relieve the hyperæmia of the gland and diminish the pressure. We should also bear in mind to avoid the much-feared bending of the head backward (Seydel), especially during the operation for tracheotomy. We should be provided with a long flexible (metallic) tracheotomy-tube in case the usual tube either does not reach or does not pass the obstruction in the trachea. Escherich[11] suggests the feeding with large doses of thymus. Of course, there can be no proper therapy where there is no pathology.

The thymus gland of the animal has lately become important in many practical respects. In physiological chemistry and bacteriology it is used largely on account of its richness in nucleo-proteids. Baumann[12] discovered in the thymus the presence of small quantities of iodine. The thymus gland of the lamb and the calf has lately been employed with good results in the plain goitre and in Graves' disease.[13] On myxœdema the thymus has no effect at all (v. Eiselsberg,[14] Firbass,[15] Escherich[16]). Cunningham,[17] however, has seen some alleviating effects of the thymus upon thyroidless dogs.

Of the function of the thymus gland we have not the slightest knowledge. We cannot fail, however, to note the very recent experimental reports of Abelous and Billard.[18] They have removed the thymus in frogs and state that the animal shows great fatigue; its green color soon becomes changed, and the blood becomes hydræmic. By grafting the thymus of another frog in the abdomen of the thymus-less frog all the symptoms disappear. The future will show how much there is in this important statement.

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OBESITY.

Definition.—By obesity we designate an abnormal accumulation of fat all over the body in those tissues which in normal conditions contain a moderate amount of fat. This abnormal accumulation of fat is due to a disturbance in the metabolic processes of the body. It will be profitable to preface the remarks on the treatment of obesity by a short discussion of some of the laws governing the normal process of metabolism.

Some of the Laws of Metabolism.—The manifestations of animal life mainly consist in two forms of kinetic energy—heat and motion. The food of the animal body consists of proteids, fat, and carbohydrates. Their high complex molecules represent a considerable amount of potential energy. By the dissociation of these molecules and subsequent oxidation to simpler products the potential energy becomes converted into kinetic heat or motion. The final products of the oxidation are water, carbon dioxide, and urea.

For a long time the simple teaching prevailed that each kind of food attends to the corresponding tissue—*i. e.* the proteids of the body are supported by the ingested proteids, the fat is derived from the fat of the food, etc. Liebig, however, demonstrated that animals can be fattened by being fed with carbohydrates alone, and advanced the theory that the carbohydrates are the only source for the production of fat

in the animal body, and that the ingested fat is never deposited as fat-tissue. This opinion was dominant for many years until Voit and Pettenkofer came out with their theory that the fat of the body is largely derived from the ingested proteids. According to their accounts the nitrogen found in the excreta, especially in the urea, shows the decomposition of a larger amount of proteids than would correspond to the quantity of carbon present in the excreta, and concluded therefrom that a part of the ingested proteids are decomposed into non-nitrogenous products which are retained in the body as fat. The carbohydrates, according to their view, have to do with the formation of fat only in so far as they serve as a ready source of the liberation of energy, thus protecting the non-nitrogenous products of the decomposing proteids from being oxidized to the final products of CO_2 and H_2O. Pflüger, however, has shown that there was quite an error in the calculations upon which this theory was based, and that none of their experiments offered a conclusive proof that fat is directly formed from proteids. We mention here these theories because several of the methods of dietetic treatment of obesity which are still in vogue are based upon these different theories of the origin of fats in the animal body.

The following view of the final fate of the ingested food-stuffs within the animal body might be considered as the one at present entertained by most of the physiologists. The ingested proteids are partly utilized as "tissue-proteid," *i. e.* the deposition of the unchanged nitrogenous material in the body-tissue either to supplant the wasted proteids or to add new proteid tissue required to accomplish the growth or the hypertrophy of the body-organs; partly the ingested nitrogenous foods are stored up in the tissue-spaces as "circulating proteids," being there in readiness to meet several requirements. It might protect for some time, in case of starvation, the proteid tissue of the organ from being wasted; it might immediately become decomposed and oxidized to the final waste-products of the proteids, *i. e.* urea, carbon dioxide, and water, thus converting the stored-up potential energy into heat and labor; finally, it might split up into a non-nitrogenous product and be stored away in some of the body-tissues as glycogen. The ingested fat is under normal circumstances burnt up into CO_2 and H_2O, thus providing the body with a considerable amount of kinetic energy. Of the ingested carbohydrates one part is stored up as such in the body (sugar in the blood, glycogen in the liver, epithelium, etc.); another part is utilized for the maintenance of the energy of the body by becoming oxidized to CO_2 and H_2O, a process which the carbohydrates can undergo with readiness, as H_2O exists already, so to say, in a preformed state in its molecule. Finally, a third part of the carbohydrates becomes con-

verted into fat, which is stored away in the body. It seems that under normal conditions the carbohydrates form the sole origin of the fat-tissue of the body. We may also admit that the proteids contribute to the accumulation of fat, but only in an indirect way, by the conversion of the glycogen coming from the proteids into tissue-fat. However, it seems that the contributions from this source form only a small factor in the formation of the body-fat.

From the foregoing statement it can be seen that the services rendered by the three kinds of food-stuffs to the maintenance of the animal life consist mainly in the creation of energy liberated by the process of decomposition and oxidation—*i. e.* by the combustion of the ingested food-stuffs within the body. The amount of energy thus derived from the metabolic combustion of the food-stuffs within the body is exactly equal to the energy liberated by the combustion of the same stuffs outside of the body. The energy developed by the outside combustion consists, of course, in the form of heat. We measure this kinetic energy by calories, that is, by the amount of heat required to increase the temperature of one cubic centimetre of water one degree C. This is a small calorie. By a large calorie is meant the quantity of heat required to elevate the temperature of one kilogramme of water one degree C. Each of the food-stuffs furnishes a constant quantity of energy—combustion equivalent—which has been determined by many investigators. One gramme of proteid yields about 4.1, one gramme of carbohydrates about 4.1, and one gramme of fat yields 9.3 large calories. When we know the quantities of the three stuffs taken in twenty-four hours, we should also know how much energy or how many calories were offered to the body. But this does not tell us the exact amount of combustion which has actually taken place, as not all the consumed food is digested and absorbed. Therefore other methods have been devised to determine the number of calories yielded by the ingested food-stuffs within the body.

There are at present two methods employed for this purpose. One is to determine directly the amount of heat the animal body develops in twenty-four hours. The other method is to determine the amount of nitrogen and carbon excreted in twenty-four hours, and thus the exact amount of food-stuff which was actually combusted in twenty-four hours can be calculated. By determining the N and the C found in twenty-four hours in all excreta (including fæces, etc.) and comparing it with the food partaken in twenty-four hours it can thus be established whether there has been as much expenditure as income (nitrogen- and carbon-equilibrium); or whether more combustible material was ingested than expended, the body storing up the balance; or whether, finally, more material was burnt up than ingested, the body consuming its savings or touching the capital.

The ingestion of food (and inhalation of oxygen) constitute the income, and the muscular exertion and heat-production are the expenditure, of the body. Less income or increased expenditure, or both, cause waste; more income or less expenditure, or both, cause obesity.

Etiology.—The opinion seems to prevail that the chief cause of obesity is to be found in chronic hyperfeeding—*i. e.* the patient partakes constantly more food than he requires for keeping up the metabolic equilibrium of his body, with the result that a surplus of the ingested food is stored away, mainly as fat. This implies that the metabolic function of the body is exactly the same in obese as in non-obese individuals. Obesity, then, is not a disease, just as general waste of the body due to starvation cannot be considered as a disease. It seems to me that this conception cannot hold good for all the cases of abnormal accumulation of fat in the body. It should be remembered that there are many individuals with striking obesity who are living on only an average diet belonging to the individuals of their height, age, and mode of activity. Further, it is quite certain that one and the same amount of excessive diet leads in different persons to different results, say in one person to a weight of 250 pounds, and in another to a weight of 350 pounds. On the other hand, there are persons who habitually consume quantities of food far above those assigned to the "average diet" without gaining by it any abnormal amount of fat. In fact, with some thin persons we can never succeed in making them gain flesh by any amount of overfeeding. Again, in many cases of obesity heredity is quite a pronounced factor. Further, the fact that the female sex shows a greater aptness to obesity is surely not sufficiently explained by their diminished activity. Then, obesity in the female sex often sets in after parturition, even without lactation, or with lactation, but especially so with the cessation of the menstrual flow. Here the increase of fat is apparently not due alone to an increase of income of food, or decrease in expenditure. But, above all, the following two well-established facts seem to be quite significant for the question of the origin of obesity: (1) Castration gives rise in both sexes to the development of fat in animals and man. (2) Feeding with thyroid reduces obesity in man and animals. Here we see that the simple removal of a gland causes the accumulation of fat, and that the introduction of the substance of another gland into the body causes the disappearance of fat; in other words, the presence or absence of a surplus of fat in the body is due, in these cases at least, to the absence or presence of some gland-tissue in the body and in a measure independent of the amount of the ingested food. Taking all these and similar other points in consideration, I arrive at the following conception of the origin of obesity:

The normal metabolism of the body stands under the care of an agent or rather of agents who supervise the proper distribution of the ingested and absorbed food-stuffs among the several functions of the metabolic process. There is an agent which guards the conversion of carbohydrates, especially of the glycogen of the liver, into sugar, normally carried in the blood, which is not to exceed 0.2 per cent. There is another agent stationed in the thyroid gland guarding against the formation and accumulation of myxœdematous tissue. Further, there is probably an agent, whose character and domicile we as yet do not know, but whose task it is to prevent the retrogressive metabolic products of the proteids from being deposited as uric acid in the tissues of the body. And there is, I suggest, an agent whose task it is to permit only a small part of the body's income to serve as a deposit in the fat-cells. With all the agents doing their duty there is a physiological, harmonious working of the machinery of the metabolic process: no matter how much sugar is ingested, no diabetes will come; no matter how much proteid is absorbed, no arthritic diathesis, no gout need appear; and probably, no matter how much food is consumed, there need not be any obesity. However, if the glycogenic agent is lax in the performance of his duty, large amounts of ingested glucose will force the entrance of some sugar into the blood, causing temporary glycosuria, and if the agent is entirely absent from his post, then even small amounts of ingested carbohydrates find their way unchecked into the blood and cause the condition known as diabetes. We believe that the same applies to the condition known as obesity. If the agent guarding against the conversion of the body's combustion-material is doing its duty carelessly, an overflow of the body with combustion-material—by overfeeding—will cause a deposition of fat in the connective-tissue cells; but if the agent is entirely off his post, then even an average diet will gradually lead to obesity.

We know as yet very little of the real nature of the agent guarding against lipomatosis, but it seems that we already know something about the glands serving as domiciles for our agents, and, after all, this kind of information is all we possess of the agent guarding against myxœdema or the agent controlling the production and distribution of sugar. It is just our knowledge of the latter agent which might serve us as an instructive instance. Von Mering and Minkowski discovered that the total removal of the pancreas produces diabetes. Now the pancreas, besides controlling the production of sugar by "internal secretion," has other well-known functions. Again, even if the sugar-controlling function of the pancreas be perfectly intact, diabetes can be produced by other known and unknown agents. We learn here two important facts: That one and the same gland can attend to two or more separate functions, and that one function can

be attended to by two or more agents. As to the over-production of fat, we have seen that the feeding with thyroid gland reduces lipomatosis and prevents the reaccumulation of adipose tissue. The thyroid gland, then, secretes, besides the substance preventing a myxœdematous degeneration, also a substance assisting in the prevention of abnormal formation of fats. On the other hand, the removal of the generative organs is often the cause of the deposition of much fat in the body. This looks as though these organs, besides attending to their known function, assist by some "internal secretion" in keeping down the tendency to obesity. There is nothing in the way of assuming that some more organs participate in a larger or lesser degree in the same task.

This is not the place to dwell much longer on the particulars of this theory; I wish only to emphasize with a few words its main points. The normal course of the metabolic processes of the body is guarded and controlled by factors furnished by the "internal secretion" of some of the glands of the body. This applies also to the deposition of the proper amount of fat in the body. The abnormal accumulation of fat indicates a disturbance of function, a diminution or entire suspension of activity of one or more of the controlling factors. Obesity, then, is a disease caused primarily by a disorder in one of the links of the metabolic chain; the consumption of too much food is only the external cause of the condition.

Extent and Course.—As a moderate deposition of fat in some parts of the body must be considered as normal, it is impossible to draw a distinct line between the normal and abnormal accumulation of adipose tissue, at least in moderate cases of obesity. For practical purposes we may accept a certain standard of weight for a certain height and age, and then consider an addition of 20 per cent. of weight as being yet within normal. We might also be guided by the amount of inconvenience the obesity is causing the patient; this, however, varies within a wide range. I know a patient who bitterly complains of the annoyance her fat is causing her at a weight of 170 pounds, and I know another one who has no complaint to make whatsoever at a weight of 330 pounds. The amount of fat which can be deposited in some obese individuals seems to be enormous, and often considerably exceeds the weight of all the other tissues of the body taken together. The Fat Men's Club in New York counts many members whose weight exceeds 300 pounds. An actor in Dresden, Nicolini, weighed 560 pounds; when he knelt on the stage a valet had to help him to get up.[1] E. Bright, an Englishman, weighed 616 pounds.[2] Daniel Lambert weighed 729 pounds.[3] Kisch quotes Wadd

[1] Froelich, *Eulenburg's Real Encyklopädie*, 2 Aufl. Bd. vi., S. 455.

[2] *Philosoph. Trans.*, vol. xlvii. p. 188. [3] Duckworth in Allbutt's *System*, vol. v. p. 615.

as an authority for the statement that there was a man in New York who weighed 1100 pounds.

Obesity in its moderate degrees can be borne without much inconvenience and does not lead to serious disturbances in any of the functions of the body. Higher degrees of obesity, however, are usually of great annoyance, and earlier or later cause serious effects which will eventually endanger life. The patient is short of breath, fatigues easily, perspires at the slightest provocation. There is often present a certain laziness of the body combined with sluggishness of mind. Fat gradually infiltrates the tissue-spaces between the muscle-fibres, covers and infiltrates the heart, accumulates in the liver, causing congestion within the portal system, with their consequences of œdema, albuminuria, hæmorrhoids, etc. It leads also to sterility, to premature amenorrhœa, to loss of the sexual instincts, and to impotence. It causes often glycosuria and sometimes real diabetes. It is often complicated by gout. It leads to arterio-sclerosis, fatty degeneration of the kidney-epithelium and of the muscle-fibres of the heart, and to sudden death from cerebral apoplexy or from paralysis of the heart.

Treatment.

The chief measure for the reduction of the surplus amount of fat is the regulation of the diet, or rather its reduction. For the theory that obesity is primarily a functional disease of the metabolism, the regulation of the diet would appear to have the value only of a symptomatic treatment, inasmuch as the main object of the therapy should be the administration of a remedy for the re-establishment of the disturbed function. We do not possess such a remedy. However, our efficient treatment of the other diseases of metabolism, like diabetes and myxœdema, is, after all, not more than a symptomatic one. The most efficient treatment of diabetes is the withholding of carbohydrates, and the only treatment of myxœdema is the increase of the expenditure by the administration of the thyroid. In both cases the disease returns when the treatment is discontinued.

As has just been said, the regulation of the diet, the methodical and strict supervision of the amount and character of the patient's food, has always been and is still the chief aim in treating obesity. There are quite a number of specified bills of fare for the diet of obese patients; they were made up by different writers according to the views they held with regard to the origin of the formation of fat in the animal body. These bills of fare are frequently termed "cures." Three of these "cures" are best known and are quoted by all writers on obesity. They are Banting's cure, Ebstein's cure, and Oertel's cure. We shall describe them here briefly.

Banting's Cure.—William Banting was an obese gentleman who followed out a certain diet prescribed for him by his physician, William Harvey. He was so much pleased with the result of his diet (he lost 35 pounds) that he described it in an open letter for the benefit of the public.[1] His bill of fare is as follows:

Breakfast.—Four or five ounces of beef, mutton, kidney, broiled fish, bacon or cold meat of any kind except pork; a large cup of tea (without milk or sugar), a little biscuit, or one ounce of dry toast.

Dinner.—Five or six ounces of any fish except salmon, any meat except pork, any vegetable except potato, one ounce of dry toast, fruit out of a pudding, any kind of poultry or game, and two or three glasses of good claret, sherry, or Madeira (champagne, port, and beer forbidden).

Tea.—Two or three ounces of fruit, a rusk or two, and a cup of tea without milk or sugar.

Supper.—Three or four ounces of meat or fish, similar to dinner, with a glass or two of claret.

For a "Night-cap," if required.—A tumbler of grog (gin, whiskey or brandy, without sugar) or a glass or two of claret or sherry.

We see that this bill of fare permits plenty of meat and fish, is also quite liberal with alcohols, but cuts down carbohydrates and avoids especially fat. It is evident that it was built up upon Liebig's conception of the origin of fat. This diet has been largely employed and with quite satisfactory results, *i. e.* as far as the obesity is concerned; but it aroused also quite an extensive opposition on account of the many harmful effects which this sort of diet, so it is claimed, produces: It destroys the digestion, it produces general weakness, it leads to arthritis, it favors the development of tuberculosis (?), it leads to insanity, and it has been the cause of many deaths.

Ebstein Cure.—The diet which was recommended by Ebstein for the reduction of obesity is quite the reverse of the Banting cure. It is as follows:

Breakfast.—One large cup of black tea, about 250 grammes, without milk or sugar, 50 grammes of white or toasted brown bread, with plenty of butter. (In winter about 7.30, in summer about 6 or 6.30 A. M.)

Dinner (between 2 and 2.30 P. M.).—Soup, often with marrow, from 120 to 180 grammes of roasted or boiled meat, vegetables in moderation, leguminous preferably, but also cabbages. Owing to their saccharine ingredients, turnips were almost and potatoes altogether excluded. After dinner a little fresh fruit when obtainable. As *compote:* Salad or occasionally some stewed fruit without sugar. *Beverage:* Two or three glasses of light white wine. Immediately after dinner a large cup of black tea without sugar or milk.

[1] *A Letter on Corpulence, Addressed to the Public.* London, 1863.

Supper (from 7.30 to 8 P. M.).—In winter almost invariably, in summer occasionally, a large cup of black tea without milk or sugar. An egg or a slice of fat roast beef, or both, or some ham with its fat; Bologna sausage, smoked or fresh fish, about 30 grammes of white bread well buttered, eventually a little cheese and some fresh fruit. Sugar, sweets of all kinds, and potatoes are forbidden.

Ebstein cuts down meat and reduces also carbohydrates, but allows quite large quantities of fat. Ebstein was apparenty influenced by the theory of Voit that the proteids contribute largely to the formation of fat. Ebstein's partiality for fat in the food is caused by the idea that fat satisfies the appetite better than proteid and carbohydrates, and that a person who partakes of fat requires a smaller amount of food. It is claimed by some writers that the reduction of obesity accomplished by Ebstein's method is due to the dyspepsia caused by the ingestion of too much fat. It deserves, however, to be especially pointed out that so far no other objection has been raised against the Ebstein cure.

Oertel Cure.—Originally Oertel's diet was arranged for the treatment of cardiac troubles, but noticing the loss of weight in the patients so treated, Oertel applied his diet also to the treatment of all cases of obesity. It is as follows:

Breakfast.—50 grammes of wheat bread; 130 c.cm. of coffee; 20 c.cm. of milk, and 10 grammes of sugar.

Dinner.—Soup 150 c.cm.; 200 grammes of stewed beef; 100 grammes of vegetables, 50 grammes of salad, 100 grammes of dessert made of flour, 50 grammes of black bread, and 125 c.cm. of Pfalzwein.

Afternoon.—130 c.cm. of coffee, 20 c.cm. of milk, and 10 grammes of sugar.

Supper.—One soft-boiled egg, 150 grammes of fried meat, green salad 50 grammes, a roll of 50 grammes, Pfalzwein 250 c.cm., and water 250 c.cm.

The amount of proteids and carbohydrates of the Oertel diet exceed those of the other two bills of fare, while the amount of fat is less than in the Ebstein and more than in the Banting diet. The main feature of the Oertel cure is the considerable reduction of the fluids which the patient is allowed to take. This, however, is by no means original with Oertel. Some twenty years before Oertel adapted it for his diet, Dancel recommended the restriction of the drinking of water as a chief means for the reduction of fat. Oertel's cure aroused quite a lively opposition from many quarters; it is claimed by some writers that it is a dangerous procedure which has caused some deaths.

The fact that a reduction of fat was accomplished by each of these

three methods of treatment shows that the success does not depend so much upon the reduction of a special food as upon the reduction of food in general, this reduction being quite considerable in all the three methods, as we shall see presently.

We have seen above that the value which the food has for the body is measured by the calories it represents. By a large number of experiments it was established that the "average diet" of an adult of medium size, in order to maintain the metabolic equilibrium, has to represent about 3000 calories. The "average diet" compounded by Voit is as follows: Proteids 118, fats 56, carbohydrates 500 grammes. This is equal to about 3050 calories. The proportion of the different foods to one another can be varied considerably, but the final sum must represent about 3000 calories. Let us now calculate the calories which are represented in the three diet-cures for twenty-four hours:

	Proteids.	Fats.	Carbohydrates.	
Banting	172 grammes	8 grammes	81 grammes	= 1112 calories.
Ebstein	102 "	85 "	47 "	= 1401 "
Oertel	183 "	38 "	143 "	= 1690 "

We see that in these diet-plans the number of calories is cut down to about one-half, in Banting even to one-third, of the number required for the normal "average diet." The "cures," then, mean practically, wasting away of the body by starvation.

At present these cures are no longer followed out so strictly, inasmuch as every "specialist" on obesity is devising his own bill of fare, but the basis of all these diet-cures is still the considerable reduction of the daily food. For instance, the diet-plan which was devised by Kisch of Marienbad, for the so-called plethoric obesity, contains about 178 grammes of proteids, 11.3 grammes of fat, and only 80 grammes of carbohydrates for twenty-four hours, which is equal to only 1081 calories. When we consider that some of the patients are used to a diet about twice as large as the normal one, this reduction would mean one-sixth of the patient's former diet.

According to Hirschfeld, during these cures the amount of nitrogen found in the excreta collected for twenty-four hours exceeds the quantity of nitrogen contained in the food partaken in that time. This means a constant loss of body-proteids, and must finally lead to a serious condition. Von Noorden and Daber, however, dispute the correctness of this statement. However this may be, for various reasons we shall not advocate here those dietetic plans of treatment which prescribe such a large and abrupt reduction of the food of the obese patient. The obese condition, though a pathological one, had a gradual development, and the metabolic mechanism gradually adapted itself, to a certain degree, to the new circumstances. Any radical and

abrupt change is liable to work like a shock and bring on an irreparable disturbance in the equilibrium. Then, such radical, unbearable measures will not be carried out by the patient for any length of time, and he will soon fall back into his old habits: that is how the patients who leave Carlsbad gain in the first week a good part of the fat they lost there; they are glad, as they say, to have a good meal again. Neither is such rapid and radical reduction necessary; the endangering and annoying symptoms are already relieved by a loss of only a few pounds, which can be attained in quite a short time by a moderate change in the food. The balance of the fat can be finally reduced by a gradual and slow increase in the reduction of the food; thus the patient's habits in eating will undergo a slow but sure change with less prospects of a relapse. The metabolic mechanism, too, I believe, will regain more resisting power against a new overflow of nutritive material by a gradual re-adaptation to the original working of the normal mechanism.

A conservative plan of dietetic treatment of obesity has been put forward quite recently by E. Pfeiffer. He recommends that the first reduction of food should be arranged upon the basis of a "maintenance diet" (*Erhaltungskost*)—*i. e.* such a diet as is required to maintain the metabolic equilibrium of the average weight of a normal body of a certain age and height. The average weight which is to be expected at a certain age and height can be found in the well-known table of Quetelet (Table I.):

TABLE I.—*Quetelet's Table, showing Expected Weight at a Given Age and Height.*

	Men.		Women.			Men.		Women.	
Age.	Height in Meters.	Weight in Kilos.	Height in Meters.	Weight in Kilos.	Age.	Height in Meters.	Weight in Kilos.	Height in Meters.	Weight in Kilos.
0 . . .	0.5	3.2	0.49	2.91	13 . . .	1.44	34.4	1.40	32.9
1 . .	0.7	0.45	0.69	8.79	14 . . .	1.49	38.8	1.45	36.7
2 . . .	0.77	11.34	0.78	10.67	15 . .	1.55	43.6	1.49	40.4
3 . . .	0.86	12.47	0.85	11.79	16 . . .	1.59	49.7	1.54	43.6
4 . . .	0.92	14.23	0.92	13.00	17 . . .	1.63	52.9	1.56	47.3
5 . . .	0.99	15.77	0.98	14.36	18 . . .	1.66	57.9	1.56	51.0
6 . . .	1.05	17.24	1.10	16.01	20 . . .	1.67	60.1	1.57	52.3
7 . . .	1.11	19.10	1.15	17.54	25 . . .	1.68	62.9	1.58	53.3
8 . . .	1.16	20.76	1.18	19.08	30 . . .	1.68	63.7	1.58	54.3
9 . . .	1.22	22.65	1.19	21.36	40 . . .	1.68	63.7	1.58	55.2
10 . . .	1.28	24.52	1.25	23.52	50 . . .	1.67	63.5	1.53	56.2
11 . . .	1.33	27.1	1.30	25.7	60 . . .	1.63	62.9	1.52	54.3
12 . . .	1.39	29.8	1.35	29.8	70 . . .	1.62	59.5	1.52	51.5

For instance, for a man of forty and a height of 168 cm. we know by Quetelet's table that his normal weight should be about 64 kilos.

Forty-eight calories is about the food-value required as an average diet for each kilogramme of the body's weight. When we now multiply 64 by 48, we find that the food of such a man must represent 3072 calories. These calories we can distribute between the food-stuffs in the proportion of proteids 17.5 per cent., fat 8.3 per cent., carbohydrates 7.2 per cent., and we then have the "maintenance diet" of this patient. In this manner we can easily ascertain to what quantities we have to reduce the food of all obese patients. If under this diet no reduction takes place, Pfeiffer recommends in the first place to increase the proteids at the expense of fat or carbohydrates, but so as to keep up the normal number of calories. If, then, there is still no reduction, or the reduction is too small, a reduction of the calories must be instituted by cutting down the carbohydrates by 50 to 100 grammes a week, thus gradually approaching the Ebstein cure.

Pfeiffer's method, conservative and commendable as it is, still has the disadvantage of starting the change with too great an abruptness in many cases of obesity. When the patient, indeed, has been in the habit of eating a good deal, perhaps twice as much as his "average diet," which is by no means a very rare occurrence, the "maintenance diet" will mean for him a sudden reduction to one-half of his usual food. The objections which I raised above against the rapid reductions in the other methods also hold good against the rapid changes occurring when treating by Pfeiffer's method. I also believe that a reduction of 400 calories a week is rather too great when the diet is already below the average: in four weeks the diet will be less than one-half of the normal.

For these reasons I propose to modify Pfeiffer's method in some respects.

In every case of obesity we should try to ascertain the quantities of food our patient is in the habit of partaking. A reduction not exceeding 400 calories should then be established for the first week; and each week the reduction should be increased by about the same amount until the line of the maintenance diet is reached. Below this line the increase in reduction must not exceed 100 calories a week, and must not go below two-thirds of the average diet. A reduction below the maintenance line should be undertaken only to meet serious disturbances or annoyances, while the reduction of the diet, as long as it is above the average line, might be instituted for less serious reasons, for a diet above the average is an abnormality in itself. Further, it should be ascertained in which kind of food the obese patient is most in the habit of indulging, and just this food should be reduced most, as there is possibly a causal connection between the indulgence in the special food and the increase of the adipose tissue. When there are no special preferences, the reduction should be distributed, as

long as the diet is still above the average, between the food-stuffs in the proportion suggested by Voit—*i. e.* 17.5 : 83 : 74.2, or, in round numbers, 18 : 8 : 74. When already below the average diet the reduction should be confined mainly to carbohydrates, as the main source for the formation of fat, while the proteids should rather undergo a moderate and gradual increase in order to meet an eventual excess in the excretion of nitrogen. While undergoing a food-reduction below the average diet, the strength, heart, urine, etc., should be watched closely, and the treatment interrupted at the first signal of a serious disorder.

The management of this treatment might appear to be more complicated than it really is. I append a table (Table II.) which shows the percentage of the proteids, fat, and carbohydrates in most of the articles of food which are in use:

TABLE II.—*Percentage of Proteids, Fats, and Carbohydrates contained in the most important Food-stuffs.*

I. ANIMAL FOOD-STUFFS.

	Proteids.	Fats.	Carbo-hydrates.
Beef (raw)	21.39	5.19	
Beef (cooked)	37.73	9.15	
Beef (fried)	32.21	7.81	
Veal (raw)	18.88	7.41	
Mutton (raw)	18.11	5.77	
Pork (raw)	19.91	6.81	
Ham (salted)	22.32	8.68	6.38
Hare (raw)	23.34	1.13	0.19
Venison (raw)	19.77	1.42	1.24
Liver-sausage	15.93	26.33	. .
Chicken	19.72	1.42	
Duck	22.62	3.11	
Codfish (fresh)	17.09	0.35	
Salmon (fresh)	13.10	4.57	4.67
Mackerel	18.80	8.20	
Pike	20.11	0.69	0.92
Oysters	8.00	13.00	1.50
Liver	19.59	5.60	1.10
Bacon (salted)	9.72	75.75	
Eggs	12.55	12.11	0.55
Milk	3.31	3.66	4.92
Cheese (fat)	27.16	30.43	2.53
Cheese (lean)	32.65	8.41	6.80
Butter	0.86	83.11	0.70

II. VEGETABLE FOOD-STUFFS.

Wheat bread	9.60	1.00	60.10
Rye bread	8.50	1.30	52.30
Potatoes	1.79	0.16	20.56
Carrots	1.04	0.21	9.40
Turnips	0.96	0.16	5.98
Radishes	1.23	0.15	3.79
Asparagus	1.98	0.28	2.74
Peas (green)	5.75	0.50	10.86
Beans	2.77	0.14	7.02
Cauliflower	2.53	0.38	5.01
Winter-cabbage	3.99	0.90	11.63
Cabbages	2.50	0.50	4.0–6.0
Spinach	3.15	0.54	3.34
Mushrooms	2.57	0.13	4.76
Cucumber	1.02	0.09	2.28
Lettuce	1.41	0.31	2.19
Sugar	. .	. .	96.73
Honey	1.29	. .	81.44
Apples	0.39	. .	12.90
Pears	0.36	. .	11.80
Plums	0.40	. .	8.24
Cherries	0.62	. .	11.15
Grapes	0.59	. .	15.32
Berries	0.50	. .	7.00
Walnuts	16.37	62.86	7.89
Chestnuts	5.48	1.37	38.34
Beer	0.49	. .	4.55
Brandy	. .	. .	69.50
White wine	. .	. .	11.82
Sherry	. .	. .	22.36
Champagne	. .	. .	11.95
Coffee	0.16	0.50	1.40
Tea	0.30	. .	0.60
Thin soups	1.10	1.50	5.70

Knowing that each gramme of proteid is equal to 4.1 calories, a gramme of fat 9.3, and 1 gramme of carbohydrates 4.1, and knowing by the Food-table the amount of proteid, fats, and carbohydrates contained in each article, we can easily compound a diet which shall represent a certain number of calories. After all, we need not be too accurate in this matter. For practical purposes the following bill of fare represents about the average diet for one day for an adult of average size: 10–12 ounces of meat, 4–5 ounces of fish, 2–3 eggs, 8-10 ounces of bread, 2-3 potatoes, 2 apples or pears, etc.; 5–6 ounces of beans or 2–3 ounces of peas, 4–5 ounces of spinach, 5–6 ounces of cauliflower, 6–8 ounces of lettuce, 10-12 ounces of milk and $\frac{1}{2}$ ounce of butter. No sugar, no pastries, etc. Such a diet contains proteids and fat a little above and carbohydrates a little below the line for the average diet. Any of these articles of food may be reduced, thrown out, or supplanted by another article in the proper proportion according to the arising necessities. It is advisable to encourage indulgence in such vegetables as lettuce, cucumbers, cabbages, etc., which represent a low food-value, but which by virtue of their bulk fill up the digestive organs and satisfy the exaggerated appetite of obese patients. In the beginning of the treatment it will be better to have the patient weigh exactly the food which he is to take. Later on he will have learned to estimate the weight of a certain piece of food by its apparent size, and a certain measure of laxity may be overlooked.

It is advisable to intrust the execution of the plan to an intelligent and energetic member of the family of the patient, rather than to the patients themselves, whose good appetite usually gets the better of them. It helps the perseverance of the patient when his bill of fare is not too monotonous; and it is harmless and psychologically useful to allow the patient once a week, say on Sunday, to indulge in his old mode of life.

In prescribing the diet we should remember that some obese persons do not consume more food than normal individuals; this is especially the case with obese patients of the so-called anæmic variety. Here we ought not to cut down the calories which are due to them, but should increase the proteids at the expense of the carbohydrates and fat.

With regard to *drinking*, so far as it refers to water, too great restrictions should not be made. It seems now to be the opinion of the majority of observers that the reduction of water may lead indeed to a reduction of the weight of the body, but only by loss of water and not of fat. A reduction of liquids to less than 1000 c.cm. in twenty-four hours is even harmful, as the kidneys may become irritated. However, in cases of obesity combined with dropsy a reduc-

tion of liquids is rather advisable, especially when the patients are in the habit of consuming large quantities of water. One or two small cups of coffee or tea without sugar and 6 to 8 ounces of any clear soup are permissible, and even advisable. Schweringer forbids liquids at meal-time, and prescribes them two hours after meals. Alcoholic beverages may be taken in small quantities as long as their calorie value is taken into account. It should be remembered, however, that, according to Miura, alcohol causes a greater decomposition of proteids in the body, and that it leads to fatty degeneration of certain tissues.

Saline purgatives have been and are still greatly in use in the treatment of obesity. Their fat-reducing effect may be due to the premature removal from the intestinal canal of a part of the food which, were it permitted to remain longer, would finally have been digested and absorbed; the effect then amounts practically to a food-reduction, the extent of which remains unknown. It might perhaps affect the weight of the body also by the withdrawal of a quantity of fluid. It is a fact that obese patients are sent to Carlsbad, Marienbad, Kissingen, etc., where they indeed often lose quite a great deal of their weight within a short period. But the strict diet the patients are put upon in these places amounts sometimes only to one-third of the average diet, and Seegen and others insist upon, and claim to have shown it by experiments, that the use of the minerals without the diet has no reducing effect upon obesity. However, my own experience is that the effect often varies with the individual: in some cases we see a distinct reduction running parallel with the administration of the minerals; in some other cases, again, there seems to be no effect or rather some small increase in weight following the frequent use of mineral laxatives; the loss in these cases is probably being compensated or even over-compensated by the improvement of the digesting and absorbing powers of the cleansed digestive canal.

Next to the reduction of the diet, *an increase of the expenditure* should be greatly encouraged. This is accomplished in the first place by an extended muscular exertion, which is in itself an expenditure of energy; then it increases the heat-dissipation, and finally it increases the number of the respirations and cardiac beats, by which increase more oxygen is brought to the blood and to the tissues, and that means better oxidation and increased metabolism. We might perhaps consider the increased perspiration caused by muscular exertion also as an effect favorable to the reduction of the body-weight. In plain cases of obesity not complicated by any disturbance in the circulatory system, all sorts of muscular activity should be encouraged, like walking, climbing, horseback and bicycle riding, rowing, etc., especially as long as the diet is above the average line. It must, how-

ever, be remembered that, if the supply of nitrogenous food is insufficient, the muscular exertion might lead to a greater excretion of urea and to a deficit in the nitrogen-equilibrium. In cases showing a disturbance of the action of the heart, the muscular work must be done with great care, and is best restricted to walks and very mild climbing, starting with a minimum and gradually increasing according to the condition of the patient. He must be instructed to rest as soon as he feels palpitation. The effects of the moderate movement can be well supported by *massage*, which also must not be of a violent character.

During sleep the muscular activity of the body is at its minimum, being restricted to the contraction of the heart and the respiratory muscles; the tonicity of all the muscles is probably also diminished. Therefore in cases of obesity *long sleep should be discouraged;* six to seven hours a day are sufficient, especially in uncomplicated cases of obesity. Obese people have a special inclination for an after-meal sleep; it should not be permitted.

Hot baths, especially hot vapor or dry-air baths (Turkish) seem indeed to reduce the weight of the body in a moderate degree, as can be established by weighing the patient before and after the bath. Whether this is due to a loss of water by perspiration or to a genuine increase of the metabolism is not yet established. We should remember, however, that in a hot atmosphere there is less expenditure of energy—people therefore gain flesh in summer in spite of profuse perspiration—on account of the diminished heat-dissipation and relaxation of the muscular energy. Hydrotherapeutists, however, claim that the weight-reducing effect of the baths occurs only when there is an abrupt change from hot to cold and that it is the shock which increases the metabolism of the body.

Medicinal Treatment.—There are quite a number of drugs on record which were at one time or another recommended by some one of more or less acknowledged authority as efficient remedies against obesity. Iodide of potassium, liquor potassæ, potassium bromide (with sodium carbonate in Barnay-Schindler reduction pills), acetic acid, etc., all were more or less often advocated, and they may indeed have effected some reduction in some cases of obesity. But the favorable results were apparently rare and not sufficiently convincing, and therefore none of these remedies has ever gained general acknowledgment. We need not enter upon any discussion of the merits of any of these drugs, the more especially as we now possess an internal remedy for obesity, the efficacy of which became universally acknowledged within a short period. It is—

The Thyroid Treatment.—In our article on the Diseases of the Thyroid we took occasion to describe in detail the treatment of myx-

œdema with preparations of the thyroid gland. The striking reduction of the myxœdematous tissue in cases of myxœdema and cretinism soon gave rise to the trial and testing of the effect of the thyroid-feeding upon the accumulation of adipose tissue. Barron[1] was the first to record a reduction of ordinary corpulence by the administration of the thyroid, and James J. Putnam[2] recorded reductions of 40 and 47 pounds by this treatment, and soon quite a number of similar reports commenced to come in from all sides. Now it is a universally acknowledged fact that the thyroid rarely fails to reduce the weight of obese individuals. At first the thyroid was used in large doses, and there seemed to be no limit to the degree of reduction possible to attain by this treatment. In a discussion following the reading of my paper on the thyroid-therapy a trustworthy gentleman reported the case of a very obese patient who lost 100 pounds by the treatment with thyroid.

We know now that it is neither proper to use too large doses of the gland even in simple obesity, nor is it justifiable to accomplish such extraordinary reductions. Large doses of thyroid bring out in healthy persons also a number of discomforting symptoms, though they seem never to become as serious as they were found in the cases of myxœdema overdosed by thyroid (thyroidism), nor do these symptoms develop in all individuals; there are normal persons who can stand quite large doses of thyroid without experiencing any disagreeable effects. Another point of importance which has to be taken into consideration while treating obesity with thyroid, is the fact that the decomposition of nitrogenous material has a distinct share in the loss of weight which is caused by the ingestion of thyroid (Wendelstadt and Bleibtreu). That this, however, is not the only cause of the reduction, as was apprehended by some writers, was proven, first, by the fact that the loss of carbon during the thyroid-feeding exceeds greatly the amount of carbon present in the quantity of the decomposed proteids as calculated by the excreted nitrogen; and secondly, by the considerable increase of the general metabolism as seen in the striking increase of the inhaled oxygen and the exhaled carbon dioxide (Magnus-Levy). Further than this, the deficit and the nitrogen-equilibrium can be met to some degree by the addition of proteid to the usual food of the person under treatment. Cunningham kept up animals simply by feeding them on thyroids alone, the proteids of the thyroid serving as food. The reduction of the body by the thyroid-feeding takes place without the aid of a change in the diet. An increase of the diet, however, overbalances the reducing effect of the thyroid-feeding.

[1] *Liverpool Med.-Chir. Journal*, Jan., 1893.

[2] *Trans. of Assoc. of Amer. Physicians*, May, 1893.

My own experience with the treatment of obesity by thyroid is of the most satisfactory kind, none of my patients having ever had a complaint to make. But I never have given too large a dose, have never allowed the reduction to exceed 20 pounds, always attaining it gradually, and have never treated obesity for any other than good medical reasons. I begin with small doses, 3 to 5 grains of the fresh gland, increased very slowly while constantly having the patient under observation, discontinue the administration of the thyroid at the first sign of some disturbance, and never go above 15 grains a day even if well tolerated. In nearly all of the cases I have seen a reduction of weight finally follow a careful, prolonged, and patient administration of the thyroid. In a part of the cases the administration of the thyroid had often to be discontinued, and we had to be satisfied with the mere checking of the increase of weight. In all cases where a distinct discomfort, especially shortness of breath, was present, a pronounced relief was experienced by the patient shortly after the beginning of the treatment and long before there was any sign of a loss in weight. This is in accord with the observation made by some investigators that the change in the respiratory quotient (increased metabolism) shows up before there is yet any decrease in weight. When larger doses of thyroid are given with a satisfactory result, the dietetic treatment I advise is moderate out-door exercise like walking, etc., and a moderate change in the food in favor of more proteids. The advice to take less meat, and drink instead more milk, during the thyroid treatment, applies only to the treatment of myxœdema or cretinism, and perhaps also goitre. When the effect of a full dose of thyroid is not satisfactory, the treatment is supported by a dietetic regimen according to the plan laid out above, cutting down especially carbohydrates. In obesity, too, as in myxœdema, it is wise to sometimes change the thyroid preparation. When such doses as 15 grains a day are given, it is advisable to have every third or fourth week an intermission for eight or ten days. Here, too, as in myxœdema, these intermissions help to keep up the efficiency of the remedy. When the remedy is discontinued, eventually a return to the original weight might gradually take place, especially when the thyroid-treatment was not supported by some dietetic measures. An early relapse, however, occurs mostly when the thyroid cure is hurriedly carried out and the loss of weight takes place rapidly. When the treatment has been carried out with care and patience, and the patients lose their flesh gradually, so to say imperceptibly, the effect keeps up after discontinuation of the treatment for a long time.

We can say that, when the thyroid administration is carried out discreetly and discriminately, with patience and with care, and is supported with such moderate dietetic measures as every patient can

easily carry out, the treatment of obesity becomes an exceedingly thankful task.

I have had some experience also with the employment of iodothyrine for obesity. While I can confirm the fact that iodothyrine is capable of reducing fat, I must say that its effect on obesity is a good deal slower than even in myxœdema. As there is hardly any drawback, when the thyroid is handled with care, there seems to be for the present no good reason for a general recommendation to substitute the thyroid by the expensive iodothyrine. However, I had one patient whose stomach could not stand a minimal dose of the desiccated thyroid, but who took without trouble quite large doses of iodothyrine with undeniable effect.

Besides the favorable effect of the thyroid treatment upon general obesity, I have had excellent success with this treatment in a case with multiple lipomata. The numerous sensitive swellings totally disappeared within five months.

There is at present a general consensus of opinion to avoid the thyroid treatment in all cases of obesity which show some heart symptoms. By my observation of the early relief which some obese patients with shortness of breath and similar discomforts derive from a few doses of thyroid, I was led to the theory that it is at the heart that the first removal of the fat begins to take place, and I started to try cautiously very small doses of thyroid in cases of fatty infiltration of the heart. Without insisting upon the correctness of my theory, I can state that the practical results are exceedingly satisfactory to me. I quote briefly a few instances:

Mrs. K., thirty-eight years of age, always somewhat stout, and with a systolic murmur, ceased menstruating about three years ago and became gradually very stout, especially in the mammary, abdominal, and gluteal regions. Recently she became very sick, had five to six characteristic spells a day of angina pectoris with extreme præcordial pain penetrating to the back and radiating into the right arm, constant bradycardia, pulse forty to forty-four per minute, profuse perspiration, shortness of breath, etc. Percussion of heart impossible on account of fat. Nitro-glycerin made the condition worse; iodides, strychnine, valerian, bromides, iron, etc. had no effect. I gave her two and a half grains of desiccated thyroid once a day. After thirty-six hours the pulse went up to sixty per minute, the attacks subsided entirely, the patient stating that a certain inside pressure is leaving her and she can breathe better. After two days more the pulse went up to seventy-two per minute and the patient left her bed. She had no other treatment during this time.

Miss S., seventeen years of age, short, becomes constantly stouter, looks exceedingly anæmic, has often fainting spells, and can hardly walk.

Systolic murmur, moderate dilatation. Diagnosis: Anæmic obesity. Arsenic of no use. Blaud's pills improve color but not the fainting spells. Prescribed iodothyrine, 5 grains daily. After four days no more fainting spells; walks now three to five miles a day; lost one pound in two weeks; and she and her family are delighted.

Mrs. P., forty-eight years of age, menstruation still regular, weight increasing, now 192 pounds, for years has had "asthma." Condition now intolerable, cannot climb the stairs, slightest exertion causes dyspnœa and palpitation, profuse perspiration, sits up nights in bed. Heart-sounds clear but hardly audible, râles in the lungs, œdema of the legs, etc. Diagnosis: Fatty infiltration of the heart. I gave her two grains a day of the desiccated thyroid (Parke, Davis & Co.). There was a distinct relief even the next day. The dose was gradually increased to 6 grains a day, which she has taken continually for fifteen weeks. She lost eighteen pounds; œdema, palpitation, "asthma," perspiration, fatigue, are all gone.

With regard to the *literature* on the subject of obesity I refer to the works of W. Ebstein: *Die Fettleibigkeit und ihre Behandlung;* Oertel, art. "Obesity," *Twentieth Century Practice of Medicine*, vol. ii.; K. Kisch: *Die Fettleibigkeit* (*Lipomatosis universalis*), and E. Pfeiffer: *Die Behandlung der Fettleibigkeit*, in *Penzoldt und Stinzing's Handbuch der speziellen Therapie*, vol. ii. part 2, p. 16; Dyce Duckworth, art. "Obesity," Allbutt's *System of Medicine*, vol. v. The reader will find in these works complete lists of the literature of this subject.

CHRONIC ARTICULAR RHEUMATISM, RHEUMATOID ARTHRITIS, AND GOUT.

By JAMES STEWART, M. D.

CHRONIC ARTICULAR RHEUMATISM.

Under the term chronic articular rheumatism various clinical types of arthritis are met with which vary much no doubt in their causation as well as in their course and duration. Clinically, the following more or less well-marked forms are commonly met with:

I. Cases of chronic arthritis attended by stiffness and occasional, or more or less constant, pain in the joints and neighboring parts, occurring either spontaneously or following attacks of either acute or subacute rheumatism, but unattended by pyrexia or other symptoms of constitutional disturbance.

II. A second type is chiefly characterized (in addition to the symptoms of the first type) by deformities arising from permanent changes in the soft and, to a slighter extent, in the bony tissues of the joints. This second type is in many instances an advanced stage of the first. Such changes may be an early manifestation of the rheumatic process, and clinically bears a very close resemblance to certain types of rheumatoid arthritis. In fact, a differential diagnosis is in the early stages often a matter of difficulty, if not an impossibility. In both diseases we often meet with a very pronounced degree of atrophy of the muscles in the neighborhood of the joints.

That chronic articular rheumatism is often a result of chronic infection in a mild degree is highly probable, while rheumatoid arthritis is the outcome of a more virulent infection. We have no bacteriological evidence to show that any one form of micro-organism is the essential cause. Evidence is accumulating that the toxic action arises within the body as the result of imperfect metabolism in some cases. We know so little about the essential nature of the disease that our treatment is simply the employment of those general and local symptomatic measures which only indirectly have any influence over the causes of the disease.

Hygienic Treatment.—A dry, warm, and uniform climate is the most suitable for chronic rheumatics, but only a very few can avail themselves of the benefit to be obtained from climatic changes. The

disease is mainly met with in the poor laborers or cabmen of cities and among the farmers in the country—classes which are unable to make any change.

The chronic rheumatic should live in a dry and warm dwelling. He should wear flannel next the skin. Attention to these general measures constitutes the hygienic treatment of the disease. They act by preventing the well-known exciting causes of the disease. It is of importance also to attend to the general constitutional state. If this is in a depressed condition, the administration of cod-liver oil, arsenic, and iron is called for. Through these means we increase the resisting powers of the tissues, and therefore lessen the tendency of the articular tissue to take on inflammatory action. The direct treatment of the disease includes general and local measures.

General Measures.—Unfortunately, we have no measures of any value. Salicylates, alkalies, and quinine are in the great majority of cases of little or no value. At times we meet with cases in which the salicylates appear to give a degree of relief, but it is questionable whether they have any direct influence. No doubt during the course of chronic rheumatism we meet with regular superadded subacute inflammatory attacks, and in such cases relief would be expected from the salicylates; but whether these agents have any direct influence over the cause or causes which underlie chronic rheumatism remains to be proved.

A number of observers speak very favorably of the action of ichthyol in chronic articular rheumatism. It can be administered in the form of the sulpho-ichthyolate of sodium or lithium in doses of from 10 to 30 grains. Owing to its disagreeable, tarry odor, it should be given in capsules or konseals.

Local Treatment of Chronic Articular Rheumatism.—When the joints and neighboring structures are the seat of much pain, certain local palliative measures are required. One of the most efficient for the relief of pain is the application of Paquelin's cautery. A liniment composed of belladonna (7 parts) and the chloroform of belladonna (1 part), sprinkled on impermeable piline or the textile side of American oiled cloth is an effective local application. An ointment of the sulpho-ichthyolate of zinc or a plaster of the sulpho-ichthyolate of lithium may also be used with advantage.

The Use of Mineral Baths in the Treatment of Chronic Rheumatism.—From time immemorial mineral baths have been a favorite method of treating chronic articular rheumatism. The warm sulphur and alkaline baths are those most prized.

In employing warm sulphur baths it is doubtful whether the quantity of sulphur is sufficient to exert any special local or general

action. In all probability the main benefit is derived from the heat. The more important warm sulphur baths on this continent are those at Banff in Alberta, Canada. The temperature of the thermal springs varies from 93° to 127° F. At this resort are to be found all the comforts and conveniences met with in the best-conducted European health-resorts.

The Arkansas thermal springs have also a well-deserved reputation in cases of chronic rheumatism. In Virginia and California there are numerous thermal springs, all having at least local reputations for the relief of chronic rheumatism.

Before deciding to send a patient to make use of thermal waters a careful examination should be made of the kidneys and circulation. Organic diseases of the kidneys, when complicated with degenerative changes in the arteries or hypertrophy of the left ventricle, contraindicate the use of hot baths. Simple hypertrophy of the left ventricle, with good compensation and no affection of the vessels or kidneys, does not necessarily contraindicate hot baths. Very old patients, as a rule, whether there is any internal organic disease or not, should avoid the use of hot baths.

On the European continent the more important hot sulphur baths are those at Aix-les-Bains in Savoy. The temperature of the water varies from 112° to 114° F. In Rhenish Prussia there are the important baths at Aachen (Aix-la-Chapelle), the temperature of the water ranging from 97° to 110° F.

The following is, according to Brandis,[1] the usual method of dealing with cases of chronic articular rheumatism at Aix-la-Chapelle: From three to four glasses of the thermal water are drunk during the course of an hour. In the intervals the patient is recommended to take gentle exercise. An hour after breakfast a bath is taken, and when all tenderness has disappeared the joints are douched with water at the same temperature as the bath, and at the same time they are gently rubbed for about fifteen or twenty minutes. Whether the patient takes rest or exercise after his bath depends on his general state and the condition of the weather.

The thermal waters of Bath, in England, have a well-deserved reputation in chronic rheumatism. The temperature of these waters varies from 104° to 120° F.

RHEUMATOID ARTHRITIS.

THE essential nature of rheumatoid arthritis is still obscure. Within a comparatively recent period, even since the appearance of the first edition of this work, evidence from many different sources

[1] *Aachen als Kurort*, S. 101.

has been brought forward pointing to the infective origin of this, not inaptly styled, pernicious form of rheumatic arthritis. There is no proof as yet furnished of the particular micro-organism that is the exciting cause. The frequency with which the disease follows various forms of infection renders it probable that the cause is not always the same. A second important factor is the onset of the disease in persons usually in the early period of degenerative life, and suffering from the presence of debilitating causes. Any cause especially that lowers the tone of the nervous system is a contributing factor. Prolonged mental anxiety, traumatism, etc., act in this way. Many cases have been recorded in which rheumatoid arthritis followed a sudden and severe mental shock. The influence of cold and damp is well known, but in what way they bring about the disease is difficult to explain. In the treatment of rheumatoid arthritis we should endeavor, first, to find out whether there is any source of infection, and to remove it, if possible; secondly, to combat any depressing influences; and, thirdly, to increase the resisting powers of the tissues. Practically, we are rarely able to do much to fulfil either of the first two indications, except in an indirect way.

As to the fulfilment of the third indication, increasing the resisting power of the tissues, we have several agents of proved value. Cod-liver oil deservedly holds a high place. It should be taken for long periods. A good custom for patients presenting symptoms of rheumatoid arthritis is to take cod-liver oil during the winter months for several years in succession.

Arsenic is also considered to be of distinct value. The well-known hæmatinic action of this agent is probably the chief factor in its usefulness. It has been shown by both Charcot[1] and Howard[2] that in the advanced stages of the severer types of the disease arsenic may prove injurious. It may revive pains that have long been dormant, and not infrequently gives rise to redness and swelling. If the drug is continued in small doses, these acute arthritic symptoms soon subside; but it is to us a matter of grave doubt whether it is advisable to persist in the use of this agent when such symptoms set in. A favorite method of administration is in the form of Fowler's solution in doses of 2 to 5 minims, well diluted, after each meal. The liquor sodii arseniatis in doses of from 5 to 10 minims is another efficient preparation. Gueneau de Mussy and Bean recommend arsenic in the form of arsenical baths, at a temperature of 90° to 97° F. It has been shown by Charcot that arsenic when used in the form of baths is not absorbed by the unbroken skin. He found that when cases were

[1] *Lectures on Senile Diseases*, p. 222 (Sydenham Society).
[2] Pepper's *System of Medicine*, p. 98.

treated with arsenic given internally the drug soon appeared in the urine, while when it was employed in the form of baths it was never detected in the urine. It appears to be clear from these investigations that whatever virtue arsenical baths possess in rheumatoid arthritis they owe to their thermal qualities, and not to the arsenic.

Iron is of considerable value in certain cases of rheumatoid arthritis. It is indicated in those cases in which anæmia is present.

The three drugs dealt with—viz. cod-liver oil, arsenic, and iron—are the more important medicinal agents used to increase the resistive power of the tissues to the disease. As fulfilling the same indications, it will now be appropriate to consider the hygienic and dietetic treatment of rheumatoid arthritis.

Dietetic Treatment.—It is important that the diet should be of a nourishing and mixed character. The practice of limiting the amount of nitrogenous food is not to be commended. Provided that there is no general or local contraindication, the patient should be directed to take as much nitrogenous food as can be digested with facility. Should there be any functional derangement of the digestive organs it must be corrected. Stimulants may be allowed, but it is necessary to lay down strict rules as to the quantity. This should not exceed the quantity necessary to stimulate the secretion of gastric juice. Malt liquors and good wines are to be preferred. When we meet with acute exacerbations of the articular inflammation it may be advisable to limit the amount of food and stimulants ; but, generally speaking, the more nutritious the diet the better for the patient.

Treatment by Drugs.—Certain drugs have been at one or another time lauded as having a direct influence in combating the disease-process. Some observers have found benefit from the salicylates. Speaking of their use in this disease, R. P. Howard[1] says : "Judging from my own late experience, and from the results obtained by Sée and other French physicians, sodium salicylate given in sufficient doses promises to be more generally useful in the more acute forms or in the actively inflammatory periods and exacerbations of the disease than any other agent. Including Sée's cases, Compagnon[2] has related seventeen examples of rheumatoid arthritis, most of them of the general progressive form, in which great improvement as regards pain, stiffness, swelling, and even deformity, promptly followed the employment of that salt, even after the failure of other remedies. It proved signally useful recently in a rebellious chronic case of my own. . . . It is hardly necessary to say that it often fails in

[1] *Loc. cit.*

[2] *De l' Utilite du Salicylate de Soude dans le Traitement du Rheumatisme*, par Jules Compagnon, Paris, 1880.

this intractable disease, but it has frequently relieved the pain and swelling and arrested the progress of it, at least for the time, even when alkalies, iodine, and arsenic had failed."

In the usual slow and very chronic forms I have never seen benefit follow the use of the salicylates. In the acute exacerbations, however, which are not infrequent, it is certainly desirable that they should be employed, as the above-quoted testimony from observers of great experience and acumen shows that they are of benefit. The salicyl preparations should be given in the full doses that are usually employed in acute rheumatism. Iodine and the various iodides are commonly held to have a marked influence for good in rheumatoid arthritis. Iodide of iron is especially recommended by Sir Alfred Garrod and Dr. A. E. Garrod. Whether iodide of potassium or free iodine has any direct influence over the course of the disease it is difficult to prove or disprove.

For a disease of such an intractable nature as the one under consideration it is not surprising to find a very numerous list of alleged remedies. The alkalies, quinine, cimicifuga, racemosa, fraxinus excelsior, colchicum, and many other drugs have been and still are recommended as being useful. From what we know of the nature and course of the disease, it appears clear that there is no medicinal agent which can be said to have any direct influence over its course.

Electricity in Rheumatoid Arthritis.—Both galvanic and faradic currents are employed, and both are used with a double object: first, to influence the general nutritional state, and, secondly, to affect favorably the articular affections.

Remak and M. Meyer were the first to recommend galvanism, the latter asserting that he has succeeded in arresting the downward progress in several cases through galvanization of the sympathetic. Erb,[1] who has treated a large number of cases by means of galvanization, has had no absolute cures, but he has met with occasional good results as far as improvement of the general state of nutrition and the local trouble are concerned. He considers that it is better to employ galvanism direct to the spine than to the sympathetic. When the upper extremities are mainly affected he passes the current through the cervical cord, and when the lower extremities are the principal seats of the affection the current is passed through the lumbar cord. The stabile current is employed daily, and the sittings should be from ten to fifteen minutes in duration. It is recommended to continue the treatment several months at least, but it is seldom that we meet with people who have patience for such a prolonged course of treatment.

A. E. Garrod, in his recent work, quotes the experience of Steav-

[1] *Handbuch der Electrotherapie*, S. 648.

enson with the electric bath in the treatment of rheumatoid arthritis. He uses a bath-tub made of some non-conducting material, as wood or porcelain, and has it filled with water at about the normal temperature of the body. A copper plate connected with the negative pole is placed at the foot of the tub, and a similar plate at the head is connected with the positive pole. A galvanometer measuring at least 250 milliampères is used. The strength used is about 200 milliampères, and it is computed that only 40 pass through the body, the remainder passing through the water. The full current of 200 milliampères is passed for about ten minutes. During the first six days a bath is given daily, and afterward on alternate days until the course decided upon has been given.

Steavenson considers that electric baths have a favorable influence over the course of the disease, and he cites instances which appear to support his supposition.

The Bath Treatment.—The treatment of rheumatoid arthritis by means of thermal baths is of great importance. Indifferent thermal waters appear to be as effective as those containing salts of various kinds; hence it is clear that the success depends almost entirely on the temperature of the water. Both natural and artificial thermal baths are employed. The former, however, are, as a rule, to be preferred, as the general regimen and hygienic conditions enforced at these places are factors of importance in the relief which patients often obtain. The practice very common in this country of patients of their own accord resorting to Turkish-bath establishments, and taking one or more baths daily for several successive days, is one which often does more harm than good. Any measures which tend to lower the general state of nutrition will invariably do harm in this disease.

At Aachen, in Germany, special attention is paid to the treatment of rheumatoid arthritis by means of douches and massage in conjunction with general baths. Rademaker,[1] of Aachen, has found marked benefit to follow this treatment even in advanced cases. He considers a temperature higher than 97° F. as injurious, owing to its debilitating effects, and to its tendency to increase the already existing too free action of the skin. Massage and douches are made use of only when the joint-affection is in a quiescent state. The latter means, in his experience, has been found of particular benefit in the mono-articular forms of the disease.

In employing thermal baths it is a good rule to counsel the patient not to take them oftener than every other day, and not to exceed more than fifteen or at most twenty baths. It is not unusual to meet with slight increase in the joint-pain after a few baths. This, however,

[1] *Aachen als Kurort*, S. 111.

usually disappears before the entire course is completed. If the aggravation is marked, the treatment should be discontinued. It is important to take note of individual peculiarities. Some patients are soon greatly benefited, while others are quickly made worse. Between these two extremes we find all possible degrees of difference.

In some cases the thermal alkaline waters appear to be most effective, while in others the sulphur thermal waters give most relief. No definite rules can, therefore, be laid down for the waters best adapted to any particular case.

The thermal waters of Wildbad, Carlsbad, Wiesbaden, Töplitz, Aix-les-Bains, and Bath, in Europe, and of Arkansas, Virginia, and Banff, in North America, are all useful in suitable cases. The chalybeate mineral waters of Langenschwalbach, Rippolsau, Spa, Franzensbad, etc. are useful when anæmia and debility are prominent symptoms.

The Hot-air Bath Treatment.—The treatment of rheumatoid arthritis by means of superheated air has during the past three years been extensively tried in many hospitals in both America and Europe. Like many other new methods, it was at first thought to be of very great value, but fuller and more extended use of it appears to show that these early claims were much exaggerated. That it does good in relieving some of the more distressing symptoms is undoubted. It appears from the writer's experience that it is especially called for in those cases of rheumatoid arthritis that set in with and are chiefly characterized by acute or subacute arthritic symptoms. When joint-pain with restlessness and sleeplessness are the leading symptoms a few hot-air baths generally quickly give relief. In the more chronic stages when all inflammatory action has subsided one finds, as might reasonably be expected, little or no benefit from hot air. Various forms of apparatus are at present used for carrying out this treatment. The profession is indebted to Mr. Louis Tallermann, of London, for first introducing this method of applying hot air. He was the first to demonstrate the safety and beneficial action of exposing a limb or part of the trunk to a temperature of 300° F. and above. He established beyond doubt that this high temperature could be borne without discomfort, provided the air was kept dry.

Besides the Tallermann apparatus, several other forms are now used, such as the Greville and Dowsing methods. In the two latter electricity is made use of to supply heat, while in the Tallermann apparatus the cylinder is heated by numerous gas-jets. It is questionable whether the recently introduced methods have any practical advantage over the Tallermann model. The therapeutic effect in all appears to be similar. The most obvious effect of the superheated air

is the production of (1) very profuse perspiration; (2) a temporary elevation in the body-temperature; (3) a temporary increase in the pulse-rate; (4) if pain has been complained of, it is generally found to have been considerably relieved; (5) after a few baths any swelling of the joints previously present is found to be much diminished.

One of the most striking results of the hot-air treatment is the quick gain in weight and the general improvement in nutrition. A patient may lose through sweating several ounces daily, but he more than makes up for this by a steady gain in weight and strength. The baths should not be administered too frequently nor given for too prolonged a period, as in weakly subjects they may seriously lessen the little strength present.

GOUT.

This subject will be considered under the following heads:

I. The treatment of the disordered state of nutrition that leads to the development of gout in its many phases.

II. The treatment of the various lesions and functional disturbances which arise from this disordered state of nutrition.

The Treatment of the Disordered State of Nutrition.—Our knowledge of the intimate nature of gout is still far from perfect. As proof, we have only to refer to the numerous hypotheses that are at present advanced by various writers. Functional derangements of the liver and kidneys and degenerative changes in the fibrous tissues have each their supporters as the cause. The humoral and neurotic theories with other observers hold sway. All these theories, individually, fall short of explaining the protean manifestations of the disease. Whatever may be the ultimate cause, there is a consensus of opinion that in certain dietetic and hygienic measures we have important means of controlling not only the usual periodic outbreaks, but also to a certain extent of preventing them.

The Diet in Gout.—It is of importance to give strict rules not only as to the quality but also as to the quantity of food. In some cases the quality of the food is what particularly calls for correction, while in others the quantity requires special attention. Every case should be closely studied on its own merits. It is routine practice to have a stated dietary, both as respects quality and quantity, for a gouty subject. Generally speaking, the reduction in quantity is of more importance than a change in the quality. A diminution in the quantity of food is especially called for in corpulent patients. In a general way, it is always well to insist on the patient never fully satisfying his appetite.

As to the quality of food specially adapted to gouty patients, authorities differ. Some are inclined to look upon the albuminous

elements as the most injurious, while others consider the carbohydrates equally as bad. Both of these contentions are in certain cases correct. It is an indisputable fact, however, that in the vast majority of cases an excess in the nitrogenous elements is what we have mainly to direct our attention to. A certain proportion of nitrogenous food is, however, necessary for the needs of the organism. Meat should not be partaken of more than once in the day. The practice of requiring a man who has attained middle age, and with it gout, to live for months, and even years, afterward as a strict vegetarian is not wise. It is only in young subjects that a total change of diet can be followed with impunity to the general health. In advising a patient as to the amount of nitrogenous food he is to take, it is important to consider his habits and occupation. If he is an indolent man, the quantity should be very small; while an active, busy man may be allowed to take more. White meats are to be preferred to those which are brown, and of forms of cooking, roasting is the best. As to other varieties of nitrogenous food, they should generally be used very sparingly. Fish, oysters, and game should especially be taken in moderation. When a patient takes a quantity of butchers' meat once a day he should take little else of an albuminous character that day. It should be pointed out to him that he must diminish the total quantity of the albuminous food, and he should be supplied with printed directions showing what to avoid both as to quality and quantity.

Fatty articles should also be taken sparingly. When used in excess they interfere with metabolism of the albuminates. In corpulent gouty patients excess of fatty food is particularly injurious, owing to its action in interfering with cellular activity. It therefore tends, when taken with albuminates, to make the corpulent more corpulent. For a gouty corpulent patient nothing can be worse than excess of albuminous, fatty, and starchy food. In the dietetic treatment of gout it is especially necessary carefully to consider the individual peculiarities of each patient. If the general state of nutrition is lowered, it will be necessary to allow a fair amount of fat, not only for its nutritive value, but also from the fact that it is not then necessary to give the albuminates and carbohydrates in more than very small quantities. Where the digestive acts are normally performed there is less objection to fatty food than where these acts are abnormal. There is considerable difference of opinion as to the advisability of allowing gouty patients carbohydrates to any extent. It is generally admitted that carbohydrates in excess are more injurious than fats in excess.

Speaking of the use of sugar in gout, Sir Dyce Duckworth says:[1]

[1] *A Treatise on Gout*, 1889.

"It is not proved that sugar by itself is harmful to the gouty; but there is evidence to show that if it be freely taken in addition to a varied and mixed diet, especially with certain articles and with wine, an imperfect fermentative process is set up in the stomach and small intestine which tends to provoke flatulency and acidity. *It is, therefore, in this manner that sugar proves harmful to those disposed to gout.*"

One meets not infrequently with gouty patients who stoutly maintain that the use of sugar does not tend to give rise to an attack of the gout, and while there is no distinct scientific proof to the contrary, it would be well to allow the patient, provided he is intelligent and careful, to be his own judge, to a certain extent, in this matter. In fact, in many matters of dietetic regimen in gout it would be wise for the physician not to adopt hard-and-fast rules, but to study carefully the peculiarities of his patient. It is only in this way that one can hope successfully to treat such patients.

As a rule, it is found that saccharine fruits are injurious to the gouty when taken in considerable quantities. Jams, tarts, and similar foods should be avoided.

With regard to other varieties of fruits, there is great discrepancy in the practice of different authorities. Some maintain that fruits of all and every kind, raw or cooked, are suitable (Fothergill, Burney Yeo). Sir Dyce Duckworth, Sir Andrew Clarke, and W. H. Draper, on the other hand, consider fruits generally as injurious. It is difficult to arrive at a conclusion in the face of such conflicting statements. That there are cases in which fruits of all kinds act injuriously is a common experience; but probably we as frequently meet with cases in which they do no harm. Provided fruits do not cause gastric or intestinal disturbance, the matter may be left to the patient. If it is found that they can be taken with a present impunity, and if there is an appetite for them, we believe they can do little harm. If, on the contrary, symptoms of gastric or duodenal dyspepsia arise, fruits should be forbidden. We believe that this practice is more rational than either of the extremes to which we have referred. It remains to be proved in the case of gout that any one of the great groups of food-stuffs is in all cases and at all times injurious.

Certain vegetables should be used sparingly, if at all, by the gouty, such as asparagus, sorrel, rhubarb, and tomatoes, on account of their containing oxalic acid. The addition of sugar to these acid vegetables only intensifies their injurious effects. Spinach is usually admitted to be wholesome for gouty patients, in spite of the fact that it is an acid vegetable. Its harmlessness is probably due to its digestibility and to its purgative action. Onions, celery, turnips, and carrots should

be used in moderation. Potatoes, pease and beans, green corn, cucumbers, and plain lettuce can be used with considerable freedom. Nuts of all kinds should be forbidden.

What fluid should those who are goutily predisposed drink? This is a question of great practical importance. It is one easy to answer, but it is difficult for most gouty patients to follow the physician's instructions in this respect. It is much easier for the average gouty man to dispense with certain articles of diet than for him to give up entirely his favorite beverage. It is universally recognized that alcohol in all its forms tends to the development of gout where there is the least predisposition. Gout is certainly to be met with in those who have always been total abstainers, but this fact does not in the least disprove the result of the accumulated experience as to the gout-producing tendency of alcohol.

Total abstinence, then, is good advice to give to all young persons who have an hereditary tendency to gout. The same advice is applicable to the great majority of gouty patients, no matter what their age may be. Practically, however, we not infrequently meet with patients who think that they cannot get along without alcohol in some form, and for this class we have to make choice of those alcoholic drinks which experience has shown to be least harmful. It is difficult in any case for the physician to decide this point. Every man is a law unto himself as far as the use of stimulants is concerned. We therefore have to rely mainly on what the patient has found to be distinctly injurious, and what, on the other hand, he can take with impunity.

The injurious effects of alcoholic liquids vary greatly in different individuals. Port wine is generally looked upon as the most injurious. It is said that its continuous use may originate gout where there is no hereditary tendency to this disease. The reason for the deleterious action of port wine is the imperfect fermentation, alcohol being added to it before fermentation is complete, in order to give it "keeping power." All strong and sweet wines are also distinctly injurious to the gouty. Champagnes, sherries, Burgundy, Madeira, the different Rhine and Moselle wines should be carefully avoided. Owing to its complete fermentation, good Bordeaux wine is the least harmful for gouty patients. Beer, porter, and stout are also great enemies to those goutily predisposed, especially when taken daily and in excess at intervals.

E. Pfeiffer[1] has shown the marked influence that both wine and beer have on the elimination of uric acid. He estimated the amount of this acid excreted daily in the urine of persons living under normal

[1] Die Natur und Behandlung der Gicht (*Verhandlungen des Congresses für Innere Medizin—Achte Congress*, 1889, S. 199).

conditions without the use of any stimulants, and found that it varied very slightly from day to day. When he gave his subjects a quantity of either beer or wine at the midday or evening meal, he found a marked diminution in the quantity of uric acid excreted. Usually it was found diminished one-half. On the following day the quantity of uric acid was found to be greatly increased, a quantity sufficient to correspond to the previous diminution. On the next day it was found that the uric acid was eliminated in decreased quantities, showing that the influence of the beer and wine extended over a period of four or five days. These experiments show the deleterious influence of an excess of wine and beer in healthy persons. It is a natural inference that in the gouty the disturbance of elimination would be much greater.

To explain the much greater injurious influence of wine and beer in the gouty, it is necessary to eliminate the alcohol as being the active factor. It is well known that certain strong alcoholic drinks, as brandy, whiskey, and rum, have much less injurious influence than either beer or wine. No doubt alcohol in all forms tends to lessen the elimination of both urea and uric acid.

The experiments of Ries, Munk, von Jaksch, and Hammond show conclusively that alcohol is powerful in preventing the elimination of tissue-waste. It is, however, the acids in beer and wine that are the most injurious. The action of acid substances in diminishing the amount of uric acid excreted has been demonstrated time and again. The uric acid is not only diminished, but the urates are got rid of mainly in the form of uric acid. By the exhibition of acids to persons in good health it is possible to bring their urine to the state we find it in persons who are at the time suffering from a paroxysm of gout. This is a sufficient explanation of the now universally recognized deleterious influence of beer and wine.

When we meet with patients who believe that it is impossible for them, without the greatest discomfort, to get along without alcohol in some form, we have to make choice of that variety which experience has shown to be the least injurious. When obtainable, fine old Scotch whiskey or good French cognac should be our choice. They, however, should always be taken freely diluted with one or other of the alkaline waters. In every case we should take into careful consideration individual peculiarities. Whiskey or brandy may in exceptional cases be the most injurious of all alcoholic beverages.

There are differences of opinion as to the harmlessness of milk for the gouty. If it is digested without difficulty, it not only is a good drink, but also an excellent food. It is, however, not uncommon to meet with patients who dislike the taste of milk or who are

unable to digest it without difficulty. In the latter class the difficulty may be overcome as directed by Burney Yeo. He advises his gouty patients to drink, about ten minutes before their first meal, a breakfastcupful of hot milk and water to which a small saltspoonful of the bicarbonate of potassium and the same quantity of table salt have been added. It is advisable to use skimmed milk, as we in this way get rid of most of the objectionable constituents, the fat and the sugar.

On scientific grounds we would be disposed to look upon water as the best of all beverages for the gouty, and, as far as we can judge from experience in the treatment of this disease, we see no reason to change that opinion. No less an authority than Sir Dyce Duckworth looks upon water with little favor as a beverage for the gouty. He says:[1] "I feel sure that Sydenham was right in condemning water-drinking for the gouty. Water alone is bad and dangerous, as I know from personal experience. When taken as the regular drink from youth upward it is beneficial. Herein lies a great clinical fact which needs to be duly considered, especially at the present time." It would have been desirable to have had some clear statement from this distinguished author quoted as to the probable or possible ways in which water may prove injurious. We can readily understand how too much water taken with the meals may so disorder the digestive process as to lead to difficult digestion, and thus indirectly bring about a disturbance of the normal elimination of tissue-waste.

The practice of drinking several ounces of hot water three or four times daily about half an hour before meals and at bedtime we have found to be of benefit. Burney Yeo, in his work on *Food in Health and Disease*, gives a copy of a diet followed by a medical man who suffered from gout and gravel. The patient always found that he would have gouty symptoms when he indulged in meat or game, or when he took more than the usual amount of claret, or when he omitted to take one or two glasses of hot water.

The special characters of the foregoing dietary are the small quantity of nitrogenous food taken and the large quantity of water. We have, on the one hand, lessened nitrogenous waste, from the small amount taken, and, on the other hand, an excellent diuretic to wash away the waste.

Tea, coffee, and cocoa can be taken by the gouty, provided the amount of sugar used is small. In some cases it is found that both tea and coffee induce dyspepsia, and in this indirect way they may prove harmful; but when taken moderately weak and not in too great quantities it is very exceptional to meet with dyspeptic symptoms.

[1] *A Treatise on Gout*, p. 425.

Natural Mineral Waters in the Gouty State.—There is hardly any variety of mineral water but what has now, or has had, a reputation in gout. Sir D. Duckworth gives the following list of different waters which have been recommended, viz.:

(1) The pure and indifferent waters; (2) alkaline; (3) alkaline and saline; (4) bitter acidulated; (5) saline; (6) sulphurous; (7) bromo-ioduretted; and (8) ferruginous. The indifferent, the alkaline, and the saline are the most important. It is a moot point to what extent the mineral waters themselves are effective in influencing the gouty state. It has, we believe, been shown that the indifferent waters are as effective as either the alkaline or the saline, and there is no doubt that the mineral constituents of the former can have nothing to do with their beneficial action; it therefore must depend on their watery constituent. They dilute the blood, and in this way tend to prevent uratic precipitation and give the eliminating organs time to get rid of uric acid. The most important factor in the beneficial results from a course of "waters" arises not from any special action of the water itself or its mineral constituents, but from the careful hygienic measures followed by patients. The rest from the accustomed labor, the change of air, the regular exercise and habits, and the rational modification of diet are all factors in the water cure. The use of the waters at home rarely leads to such good results, showing that it is from the auxiliary measures the chief benefit arises.

It has been shown by Sir William Roberts that all the salts of sodium exercise an adverse influence on the solubility of sodium biurate and hasten its precipitation. He considers that the use of waters containing sodium salts so frequently prescribed tends to bring on an attack of arthritic gout, and as a result a patient who has been tormented with irregular symptoms finds relief, owing to the precipitation into the structures of the joints of the urates floating in his blood and lymph. This he considers[1] "a rough mode of cure, and that it brings with it serious pains and perils of its own. My impression is that gouty persons should either entirely avoid springs which owe their activity to sodium salts, or should use them very sparingly; it is difficult to believe that they can do any direct good, and easy to believe that they can do direct harm. If they do any good at all, it must be indirectly, by acting on the liver and intestinal tract."

Luff[2] says: "The salts dissolved in a great many of the natural mineral waters are directly harmful in gout both by encouraging deposition of the sodium biurate and by checking solution of the gouty deposits. . . . It should be borne in mind that, owing to the

[1] Allbutt's *System of Medicine*, vol. ii.

[2] *Gout: Its Pathology and Treatment*, p. 227.

undoubted fact that sodium salts are directly detrimental to the removal of gouty deposits, those springs should be avoided which owe their activity to these salts, when the removal of the deposits is the main object to be attained." Luff considers that mineral waters containing sodium salts may be used with advantage in cases of irregular gout, characterized by sluggish action of the liver and gastro-intestinal catarrh. The most important pure or indifferent waters, and those containing but little sodium salts, on this continent are the St. Clair Spring, in Michigan, and the Caledonia and St. Catherine's Spring, in Ontario. The great majority of the Saratoga wells are impregnated more or less strongly with sodium salts. In Europe the chief wells of the same class are, in England, Bath and Buxton; in Scotland, Strathpeffer; in Germany, Gastein and Wildbad; in France, Aix-les-Bains and Contrexéville.

Climate.—It is well known that gout is a comparatively rare disease in warm climates. The reason of this is partly that the method of diet is different; but there is no doubt that the warmth is an important factor. In stubborn cases it may therefore be an advantage for a patient to live, at least during the winter months, in a warm climate.

Exercise.—In the preventive treatment of gout it is of great importance that all patients who are able to do so should take considerable exercise. Regular exercise promotes metabolism and secures the proper performance of the functions of the different eliminating organs. Therefore tissue-waste is thrown off. Where outdoor exercise is not possible, massage should be employed. It is of importance also that gouty subjects should have regular mental work.

Medicinal Treatment of the Constitutional State in the Gouty.—The employment of medicinal agents is important at times as an addition to the dietetic and hygienic treatment of the gouty constitutional state. It is, however, the duty of the physician to make clear to the patient that his safety essentially lies in strict adherence to the dietetic and hygienic measures already sketched out, and that drugs at best are only of use occasionally to meet some special symptomatic indication.

Alkalies form the chief ingredients in prescriptions for gouty manifestations. It is commonly believed that there is an excess of acid present in the blood, or rather the blood is less alkaline than it should be, but there is no evidence whatever to sustain any such view. There is abundant evidence, however, to show that increasing the alkalinity of the blood has no influence whatever on the solubility of sodium biurate. To what, if any, extent alkalies prove of benefit is still, therefore, a matter of pure empiricism. If an alkali is given, a potassium or lithium salt should, of course, be preferred

to a sodium salt. The hippurate of lithium is a convenient form of giving lithium. It may be prescribed as follows:

℞. Lithii hippuratis, ʒj;
Syrupi aurantii, ℥j;
Aquæ, q. s. ad ℥vj.—M.
Sig. A tablespoonful in water at bedtime.

As a rule it will not be found necessary to administer this or any alkaline salt more frequently than once in twenty-four hours.

The carbonate, citrate, or guaiacate of lithium may be used in the same doses as the hippurate. The granular effervescent salicylate of lithium is a pleasant form of giving this agent.

Of the potassium salts, the carbonate and the citrate are the most eligible.

The salicylates are also considered to be of value in the gouty state. A salt of lithium or potassium should be used. Piperazine, although at one time strongly recommended, has been proved to have little or no influence, either directly or indirectly, upon the gouty state.

Acute Gout.

The acute arthritis is the most important external local manifestation of the gouty state. In the treatment of this condition the general principles of the treatment of an acute local inflammation are our main guides. In all cases, whether the inflammation is mild or severe, rest is of first importance. The limb should be kept quiet and elevated. In olden times a not uncommon practice was to direct the patient to "walk off" his gout. A recent writer contends that in the majority of cases this is the proper practice to follow. It is directly contrary to what we conceive to be the only proper way. "Walking off" the gout is an attempt to treat the constitutional state when it is too late as far as the present attack is concerned.

Local analgesics of various kinds may be employed to give temporary relief. Sir Dyce Duckworth speaks approvingly of the following local analgesic:

℞ Atropinæ, gr. iij;
Morphinæ hydrochloratis, gr. xv;
Acidi oleici, f℥j.—M.
Solve et ft. linimentum.
Sig. To be painted over the painful joint with a large camel's-hair brush, and carded cotton to be superimposed, with a towel bandage.

The same author has found the following liniment, recommended by Garrod, to be very useful:

℞ Liniment. belladonnæ, f ʒiij;
Morphinæ hydrochloratis, gr. x.—M.
M. et ft. linimentum.
Sig. A teaspoonful to be mixed with a tablespoonful of hot water, and applied on lint under oiled silk every four hours.

An ointment of ichthyol is one of the most effective agents for relieving the pain attendant on local inflammation. Cocaine, menthol, and camphor chloral will also be found useful in allaying the pain of acute gouty arthritis. Occasionally patients find greater relief from warm fomentations than from anodyne applications. Blistering at some distance from the inflamed joint was a practice formerly in vogue. Local bloodletting is never resorted to at the present time.

Internal Treatment.—As to the use of internal agents in the treatment of acute gouty arthritis, there are two schools holding different views. We have, for instance, the school which maintains that there is no trustworthy agent, and that the proper treatment in such cases is a judicious local treatment, coupled with the administration of agents which stimulate the functions of the eliminating organs, and a strict adherence to a proper diet. Secondly, we have that school which places its reliance on colchicum. The alleged influence of the latter agent will be first considered.

From time immemorial colchicum has been used in the treatment of gout. The testimony in its favor is overwhelming. The preparation usually employed is the wine of the root. There are some advocates for the wine or tincture of the seeds. The latter preparations are more irritating to the gastro-intestinal mucous membrane than is the former. The dose of the wine of the root varies from 10 to 30 minims. A good practice is to begin with a comparatively large dose—20 minims—and continue the same dose until either relief is obtained or the irritating effects of the drug on the gastro-intestinal mucous membrane are apparent. Another practice, which is often efficient, is to give a single large dose at night and two or three small doses during the day—40 minims at bedtime and 5 minims at intervals of four hours during the day.

Colchicum is thought to be more effective by Lauder Brunton[1] when it is combined with purgatives or when the bowels have been previously freely acted upon. The following combination is considered valuable:

[1] *Pharmacology and Therapeutics*, p. 1051.

℞ Vini colchici radicis, ℥ss ;
Magnesii carbonatis, ʒj ;
Magnesii sulphatis, ℥ss ;
Aquæ menthæ piperitæ, q. s. ad ℥vj.—M.
Sig. A teaspoonful to be taken every four hours while the pain is troublesome.

We possess no definite knowledge as to the mode of action of colchicum in gout. The following explanations have been advanced at various times :

1. That it acts through promoting elimination by the gastro-intestinal mucous membrane and kidneys.

2. That its action is mainly to be explained by its direct cardiac depressant effects.

3. That it acts principally by increasing the hepatic metabolism.

4. That it inhibits the ferments which give rise to the production of uric acid.

5. That, owing to the induction of paralysis of the afferent nerves, the effects of the irritation of the uric acid on these structures are not felt by the patient.

6. That it has a direct antidotal action on the cause of the arthritis—that, in other words, it is a specific in the same sense as is quinine in malarial fever and the salicylates in acute articular rheumatism.

In the present state of our knowledge it is impossible to determine what part is taken by the different actions referred to. It is highly probable that it acts in several ways. A point of great practical importance is that we may obtain the beneficial effects of colchicum in gout without producing either increased diuresis, vomiting, purging, or a cardiac depressant effect. This certainly lends support to the hypothesis that it has a direct specific effect.

The Salicylates in Gouty Arthritis.—During the past decade a number of articles have appeared on the value of the salicylates in gouty arthritis, especially in its more acute forms. M. Germain Sée, Latham, Jaccoud, Haig, and Ralfe all strongly advocate the employment of the salicylates, considering them fully equal, if not superior, to colchicum. Speaking of the use of salicylic acid in gout, Sir Dyce Duckworth says:[1] "It does not always afford relief so rapidly, even when successful, as does colchicum, and not till after a day or two is its efficacy appreciated, at all events by the patient. In some cases, however, it acts promptly and decidedly. I do not think it is likely to supersede the well-established action of colchicum as a prompt deliverer from the agony of a gouty paroxysm, but it is a remedy of considerable power and usefulness by favoring excretion of uric acid

[1] *Treatise on Gout*, p. 359.

and preventing other acids in the system from causing retention of the latter."

To obtain relief from the salicylates it is necessary to give them in fairly full doses. Haig[1] considers that it is of little use to give the salicylates in less quantities than 1 drachm in twenty-four hours, and frequently it may be necessary to give as much as $1\frac{1}{2}$ drachms, or even the quantities usually prescribed in severe cases of acute articular rheumatism. When given in these large doses Haig has never seen it fail to bring speedy relief.

The salicylates should be avoided if there is any evidence of inflammatory or degenerative disease of the kidneys.

It is claimed by Haig that the salicylates act by increasing the elimination of uric acid. He thinks that the salicylic acid seizes upon the uric acid and gets rid of it in the form of a soluble salicylurate.

The Alkaline Treatment of Acute Gout.—Alkalies are of value in relieving not only the arthritic symptoms present in an acute gouty attack, but they also tend to remove or lessen the amount of uric acid present in the blood. The potassium and lithium salts are those which are usually found the most effective. Salts of either may be used alone or in combination with colchicum or salicylic acid. Certain popular nostrums for the relief of gout are combinations of all three. The hippurate or salicylate of lithium, in doses of 15 grains three or four times a day, may be relied upon as being generally efficient. Whatever alkaline salt is prescribed, the dose should be lessened as the more acute symptoms pass away. Garrod, in the acute cases, strongly recommends a combination of quinine with the alkalies.

Iodide of potassium, manganese, trimethylamine, veratrine, and many other agents have been at one time or another highly spoken of for the relief of acute gouty paroxysms. They are all, however, much inferior to those already considered.

The Dietetic Treatment of Acute Gout.—There is little to be said under this heading. The diet should be in general such as has been recommended for use between the paroxysms. If the patient is obese and robust, nitrogenous food should not be allowed on any account. In elderly persons, with deficient resisting powers, fish and white meats should be taken.

The cases of acute gout in which alcoholic stimulants are necessary or desirable are extremely few.

The Local Treatment of Chronic Gouty Arthritis.—When gouty arthritis has become chronic the nature of the local treatment will depend mainly upon the presence or absence of pain. Stiffness of the joints is nearly always present, and if pain is considerable it is not advisable to employ very active measures. Passive motion

[1] *St. Bartholomew's Hospital Reports*, vol. xxv.

and friction with stimulating liniments are the means employed to counteract the true and false ankyloses which occur in the course of chronic gout.

The uratic deposits found in various parts in very chronic gout require no special treatment. As a rule, the less they are interfered with the better, meddlesome surgery being especially to be deprecated in these cases. If the uratic deposits break down into pus, then they are to be dealt with on general surgical principles.

Retrocedent Gout.—When retrocedent gout is diagnosticated it is the recognized practice to bring on an arthritis, as in this way the severe internal manifestation is relieved. A simple and successful way of starting a gouty arthritis in one or more of the joints of the feet is to make use of a hot mustard foot-bath. Whatever general symptoms may be present are to be dealt with on physiological principles.

TREATMENT OF DIABETES MELLITUS.

By JAMES TYSON, M. D.

THE problem which confronts the physician in the treatment of diabetes mellitus may be thus stated: In the diabetic person a certain portion of the food ingested fails to serve the purpose for which it is taken, namely, the production of the heat and energy which go to make up the forces of the economy. In a large proportion of cases it is the carbohydrates, represented especially by sugars and starches, which fail thus of their purpose, while in very many cases only a part of the carbohydrate food goes thus astray, the remainder being properly oxidized in the fulfilment of its purpose. In other cases all the carbohydrate food ingested is thus wasted. In a third class of cases not only do the carbohydrates fail of their purpose, but the smaller quantity of carbohydrate physiologically formed out of proteid aliment also enters the circulation and is carried off without being utilized. It may be said, in a word, of all these foods thus disposed of that they are literally wasted and are of no more use than if they had not been ingested, passing out of the circulation in essentially the same condition as they enter it. In this respect the diabetic is a veritable Tantalus: everything is in reach but not accessible—so near and yet so far.

It is well known that the carbohydrate food ingested which is not already in the shape of glucose becomes thus converted before it enters the portal vein and thence the liver, though it may be true that much of this food reaches the liver with a lowered cupric oxide reducing capacity than glucose. Having entered the liver, it is there converted into glycogen and thence slowly allowed to pass into the general circulation as glucose, and therein consumed for the purposes named. For although it may be true as some, and especially Pavy, allege, that a small amount of glucose is present in normal urine, representing a slightly larger amount normally present in the blood, the quantities thus present are so small that they may be ignored in our practical question. More than this, as has been already intimated, a certain amount of glycogen and grape-sugar is manufactured from the proteid aliment, so that in point of fact, as was long ago shown by Bernard, even if an animal is strictly limited to proteid food the liver will still be found to contain a small amount of glycogen.

The diversion of food thus described results in the various symptoms of diabetes mellitus, of which the most essential to prove the presence of the disease is glucose in the urine.

Glucose is at no time produced by the kidney. It is simply separated by this organ from the blood in which it is in excess because it is not consumed in the normal way. The more glucose in the urine the more must there be in the blood. These facts permit us to divide diabetes into three degrees of severity: first, the mild forms of glycosuria; secondly, the moderately severe forms; thirdly, the severe forms. This classification has the advantage of being that adopted by many leading authorities on this subject, including van Noorden and Naunyn. In mild degrees of glycosuria only a small portion of carbohydrates fail to be properly converted and to serve their purpose in the organism. In such cases a partial withdrawal of carbohydrate food is followed by a complete disappearance of glucose from the blood, and, therefore, from the urine. In the moderately severe forms only an absolute and total withdrawal of carbohydrates from the food, as far as this is possible, will result in a complete disappearance of sugar from the urine. In the severe forms of diabetes, even a total withdrawal of the carbohydrates does not cause the sugar to disappear totally from the urine. In these cases even the carbohydrates which are made out of the albumin of the food and slowly admitted into the circulation are unconsumed.

It is evident from the above that two methods are applicable to the cure of this disease: First, to remove from the diet the food which is thus wasted, and substitute it by food which is capable of producing the body-heat and energy so necessary to maintain the functions of the economy. Secondly, by thus placing at rest for a time the carbohydrate assimilating functions of the economy to seek to restore its power to use the carbohydrates for their proper purpose, and thus avert their waste. Thirdly, to attain this same object as far as possible through the agency of medicines. Since experience has shown that the last is by far the least efficient in accomplishing the purposes desired, I will defer its consideration to a second place, and consider first the dietetic treatment.

Treatment of the Mild Forms of Glycosuria.—From what has been said, it is evident that in this class of cases it is necessary to take away only a part of the carbohydrates in order to accomplish our purpose, because a considerable amount is still assimilated. First, however, let us name a standard of percentage of glycosuria which experience has found to be more or less the measure of this class of cases. Thus, if, when under a mixed diet the percentage of sugar does not exceed 2, we may be justified in expecting that a partial withdrawal of carbohydrates from the food will lead to a complete

disappearance of sugar from the urine. It is true, however, that there may be as much as 5 per cent. of glucose which will disappear on such partial withdrawal of carbohydrates. Moreover, in this class of cases are found fat and gouty diabetics and persons in whom the disease appeared after forty years of age.

To carry out the purpose named, first determine by carefully conducted analyses the percentage of sugar, either from a part of the twenty-four hours' quantity or from what is in practice very frequently more convenient, a sample of the *urina cibi* passed in the evening after dinner and another of the *urina sanguinis* passed in the morning on rising. Then withdraw all saccharine articles of food of every description, including sugars for sweetening tea, coffee, and desserts; also candies and sweet fruits. At the end of one week the analysis is repeated. Should glucose still remain in the urine, all foods rich in starch, such as rice, potatoes, peas, beans, and white bread, are removed. Such conditions are furnished by Van Noorden's standard diet (No. 1).

Van Noorden's Diet Table, No. 1.—Breakfast: 75 grains of tea steeped in 7 ounces of water; 5 ounces of ham; 1 egg.

Lunch: 7 ounces of cold roasted beef; 2 ounces of fresh cucumber with 75 grains of vinegar, 150 grains of olive oil, and salt and pepper to taste; $\frac{2}{5}$ ounce of brandy with 13 ounces of Apollinaris water; 2 ounces of coffee without milk or sugar.

Dinner: 7 ounces of clear bouillon; 7 ounces of beef (weighed raw) basted with 150 grains of butter; $2\frac{1}{2}$ ounces of green salad, with 150 grains of vinegar and 300 grains of olive oil, or 3 tablespoonfuls of some well-cooked green vegetable; 3 sardines *à l'huile;* $\frac{2}{5}$ ounce of Cognac with 13 ounces of Apollinaris water.

Supper: 2 eggs (raw or cooked); 13 ounces of seltzer water.

Under this diet, if the case be a mild one, all glucose should disappear. The patient is then kept on a diet thus limited, and encouraged to eat rather more frequently of the articles of food allowed.

At this point I may state emphatically, that a patient from whose urine, and therefore from whose blood, sugar is thus kept is as well off as if he had no diabetes. Further, that so long as this state of affairs can be maintained by the diet thus limited there is no necessity for drugs, except as they may be indicated for other symptoms or ills apart and separate from diabetes. But is the patient of this class to be kept perpetually on the diet prescribed? No, not necessarily. Fortunately, however ignorant we may be of the rationale of production of the glycemia which is the primary symptom of the disease, experience has taught us that a considerable period of rest from any demand on the system for its sugar-regulating office often results, in these mild cases at least, in a recovery of the normal

assimilating function. Hence, after the urine has been free from sugar for a time, whose length must be determined by circumstances, but let us say a single month, the patient's carbohydrate assimilating power may be tried by adding, say, an ounce of white bread three times a day to the diet previously described. If after a day or two the analysis proves negative, there is no reason why this amount should not be continued. Should, on the other hand, the sugar return, the quantity of starches must be again reduced until a point is attained which will be unattended with glycosuria. If this experiment is successful, another article of food may be allowed—a potato, boiled rice—immediately returning to the more limited diet found compatible with the absence of sugar. A person with such a degree of diabetes may include in his food all the articles named below.

Food and Drink Admissible in Mild Cases of Diabetes Mellitus.—*Shell-fish.*—Oysters, mussels, and clams, raw and cooked in any way without the addition of flour.

Fish of all kinds, fresh or salted, including lobsters, crabs, sardines, and other fish in oil; fish-roe, caviar.

Meats of every variety except livers, including beef, mutton, chipped dried beef, tripe, ham, tongue, bacon, and sausages; also poultry and game of all kinds, with which, however, sweetened jellies and sauces should not be used.

Soups.—All made *without* flour, rice, vermicelli, or other starchy substances, and without the vegetables named below as not allowed. Animal soups not thickened with flour, such as bouillon, beef-tea, and broths.

Vegetables.—Cabbage, cauliflower, brussels-sprouts, broccoli, tomatoes, green string-beans, the green ends of asparagus, spinach, dandelion, mushrooms, lettuce, endive, coldslaw, olives, cucumbers (fresh or pickled), radishes, sorrel, young onions, water-cress, mustard and cress, turnip-tops, celery-tops, artichokes, gherkins, okra, parsley, or any other green vegetables.

Fruits.—Cranberries, plums, cherries, gooseberries, red currants, strawberries, acid apples, lemons, oranges sparingly—all without sugar. Acid fruits may be stewed with the addition of bicarbonate of sodium instead of sugar. (See below.)

Bread and *cakes* made of pure gluten flour,[1] aleuronat flour, soya flour, peanut flour, Chicago sanitary flour, bran, or almond flour, or inulin, with or without eggs and butter. Griddle-cakes, pancakes, biscuits, porridges, etc., made of these flours. Oatmeal porridge with

[1] The great difficulty met with in this country in obtaining a pure or nearly pure gluten flour makes it unsafe to use the so-called flours in severe cases at least. Yet as these flours contain somewhat less starch than the pure white wheat flours, they may be used in mild cases.

cream. *Where especial stringency is required the last should be altogether omitted.*

Eggs in any quantity, and prepared in all possible ways without sugar or ordinary flours.

Butter and *cheese.*

Nuts.—All except chestnuts, including almonds, walnuts, Brazil-nuts, hazel-nuts, filberts, pecan-nuts, butternuts, cocoanuts.

Condiments.—Salt, vinegar, and pepper in moderate quantities.

Jellies.—None except those not sweetened with sugar. Saccharin may be used for sweetening instead of sugar. Jellies may be made of calf's-foot or gelatin, and flavored with wine.

Drinks.—Coffee, tea, and cocoa-nibs, with milk or cream, but without sugar; also milk, soda- (carbonated) water, and all mineral waters freely; lemonade without sugar, acids, wines, including claret, Bordeaux, Rhine, and still Moselle wines, very dry sherry; unsweetened brandy, whiskey, and gin. No malt liquors, except those ales and beers which have been long bottled, and in which the sugar has largely been converted into carbonic acid and alcohol. Saccharin may be used for sweetening tea and coffee.

To be Especially Avoided.—Cantaloupes, watermelons, peaches, grapes, and other sweet melons and fruits; potatoes, white and sweet, rice, beets, carrots, turnips, parsnips, pease, and beans; all vegetables containing starch or sugar in any quantity; sweet wines, including sherry, Madeira, port, and champagne.

Treatment of Moderately Severe Forms of Glycosuria.—In these cases, as has been said, total abstinence from carbohydrate foods, as far as possible, is still attended with the excretion of a small amount of sugar, say 2 per cent., or 150 to 200 grains in the twenty-four hours. This form of diabetes is found in the young and the middle-aged; seldom in those past forty. These persons are not fat, but spare and rather inclined to emaciation; nor is gout common. In such cases all foods excluded from the diet of the mildest cases must continue forbidden, and, if possible, a substitute found for the carbohydrate foods which are being wasted. Increased ingestion of fats suggests itself as a measure which will make up this deficiency. They may be taken in the shape of butter and cream and soft cheeses. Bacon, olive oil, sardines in oil, yolk of egg, and marrow are substances which may be added to the diet for this purpose. Alcohol is also a most useful adjuvant, and may be allowed in the shape of Burgundy, Moselle, or any sugar-free wine in a quantity of half a bottle to a bottle a day; or in lieu thereof brandy and whiskey in a quantity of four to six ounces a day in divided doses. It may be that with the dietary thus modified it is not possible to remove entirely the sugar. It is, however, a comfort to know that an amount not exceeding 2 per cent. is still compatible

with good health and the continuation of a certain amount of business activity or exercise. It is my practice, however, to submit these patients once a month to an absolute proteid diet, as far as possible. I say as far as possible, for it is well known that an absolutely free carbohydrate food is impossible; that even meat and eggs contain minute quantities of carbohydrate, and 150 to 200 grains a day must be allowed for the most rigid diet possible. I add from Van Noorden's book a sample of a bill of fare which will fulfil these indications:

VAN NOORDEN'S DIET TABLE No. 2.

		Albumin. Grains.	Fat. Grains.	Alcohol. Grains.	Calories.
8 o'clock, first breakfast.	3⅓ ounces of ham	375	540		497
	1 cup of tea				
	1 glass of Cognac			127.5	
10.30 o'clock, second breakfast.	2 eggs	210	165		234
	fried in 150 grains of butter		120		
12.30 o'clock, luncheon.	5 ounces of cold roasted beef	855	120		912
	Mayonnaise made with the yolk of 1 egg and 1 spoonful of oil	45	270		
	Raw cucumber, with 75 grains of vinegar, 1 spoonful of oil, salt and pepper		225		
	225 grains of Gorgonzola cheese	60	75		
	Half a bottle of Moselle			375	
	1 cup of coffee, with 1 tablespoonful of cream.		75		
5 o'clock, tea.	1 cup of tea				144
	1 boiled egg	105	90		
	1 glass of Cognac			127.5	
7.30 o'clock, dinner.	1 cup of bouillon, with 225 grains of marrow		210		1074
	3 ounces of boiled salmon	275	165		
	½ to ⅔ pound of asparagus, with 300 grains of butter		240		
	1 ounce of smoked ox-tongue	120	80		
	3⅓ ounces of capon	225	180		
	Salad, with 75 grains of vinegar and 1 spoonful of oil		225		
	Half a bottle of Burgundy			450	
10 o'clock, night-cap.	1 glass of Cognac with seltzer-water			127.5	59

The Severe Forms.—This includes cases in which it is not possible, even by the most rigid proscription of carbohydrates practicable, to eliminate all the sugar from the urine. Here it is that even the proteid foods are formed into sugar which is wasted, and in order to check the glycosuria even proteids must be restricted. It is evident

what must be the consequences of such a course. Among such cases are children and young adults, in whom the course of the disease is always from bad to worse; and though such a course may be kept in check for a time, an ultimate fatal termination is inevitable. The plan of treatment is practically the same as that laid down in the second division, excepting that longer and more frequent periods of total restriction to proteid food must be observed, and during the intervals we must cut down still further the carbohydrates. Experience shows that their continuous prohibition is not wise, not only because the patient will not submit to it and will deceitfully use the carbohydrates, but experience also teaches us that such a course is undesirable from the standpoint of prognosis alone. There is room for much good judgment in settling the question as to how far the diet may be restricted in this grade of cases.

Treatment by Medicines.—I have given my reason for assigning the treatment of diabetes by medicines to a secondary position. That they are, however, useful to a degree, and advantageously supplement the dietetic treatment, no one having had much experience will deny. Apart from indications presented by special symptoms which may or may not have to do with the disease, my practice is to add the drugs to be considered when I fail to get sufficient results from the dietetic treatment.

The first drug I commonly employ is arsenic, preferably Fowler's solution, although arsenious acid may be used when it is not convenient to use the solution. The rule of treatment should be moderate doses long continued rather than large doses given with a view to the physiological effect and then discontinued. I have arrived at this belief as the result of experience. Having tried the method of large doses with unsatisfactory results, I now never order a dose above 4 minims (.24 c.c.), more frequently twice a day than three times a day, keeping it up uninterruptedly and indefinitely. I do not know how it acts, but I am confident it is useful as evidenced by such cases as the following: E. B., aged seventy, has been a diabetic for sixteen years; six years under my care. The quantity of sugar under a moderately restricted diet ranges from 1.5 to 5 per cent. He takes 4 drops (.24 c.c.) of Fowler's solution twice a day through the week, and three times a day on Sunday, because he is then at home all day. For example, July 10, 1899, the morning urine contained 3.3 per cent.; evening, 5 per cent. of sugar. He had taken this dose seven months when the analysis showed 0.83 per cent. for the morning urine and 1.6 per cent. for the evening urine. The Fowler's solution was then omitted for a time, when he returned, saying he was sure he was not so well. The quantity of secretion had increased; he could not retain it, and he noticed that what drib-

bled on his shirt stained it more deeply and stiffened it more than it did previously. Further, he did not feel as well. A specimen of urine analyzed after he had been a number of days off the drug showed for the morning urine 2 per cent., and the evening urine 2.7 per cent. I placed him again on the Fowler, and I have no doubt he will return improved.

I note also that while the arsenic is given a somewhat more liberal diet may be allowed. In lieu of the Fowler, arsenious acid may be given in $\frac{1}{30}$ grain (.0022 gram) three and four times a day. Another advantage of the arsenic is its tendency to keep the bowels free. Its effect in this direction may be slight, but it nevertheless exists. I may mention here that cases associated with constipation are difficult cases to help.

A more efficient drug, but more harmful in its tendency, is opium and its alkaloids, morphine and codeine. The best of the preparations is codeine, because of its producing in a less degree the unpleasant symptoms characteristic of opium, viz., constipation, drowsiness, and nausea. It is a much weaker preparation than morphine. I begin either with $\frac{1}{2}$ grain (.033 gram) after breakfast and at bedtime, or $\frac{1}{4}$ grain (.0165 gram) three times a day, increasing $\frac{1}{4}$ grain (.0165 gram) daily until the desired effect is attained or it proves ineffectual. I rarely exceed 8 or 10 grains (.53 to .66 gram) a day. Though less likely to produce the unpleasant effects referred to, it, nevertheless, does so at times, when it must be discontinued. We are equally ignorant of its *modus operandi*, but it may act by quieting irritation of the nervous system, an acknowledged centre of disturbance in diabetes. On the whole, treatment by opium and its alkaloids is best deferred until other measures fail. The coal-tar derivatives—antipyrin, antifebrin, and phenacetin—first introduced by the French school, have sometimes a similar effect in a less degree, but it is so slight that I have practically discontinued their use. Dujardin-Beaumetz is especially partial to antipyrin, and recommends 30 to 60 grains (2 to 4 grams) a day. Jambul has disappointed me, but there are those who value it highly. Fifteen minims (.92 c.c.) of the fluid extract are given three times a day, and twice as much may be given. Only when diabetes is complicated with rheumatism or gout are the salicylates useful.

Hygienic Measures and Rules to be Observed by all Diabetics.—Exercise in the open air should be practised by all diabetics to the extent of their ability, short of fatigue. The amount must be determined by each case; and although excessive fatigue is to be avoided, yet it is desirable to exercise in the face of almost irresistible disinclination against it. The effect of exercise out of doors is to increase the combustion of the sugar in the blood, and thus cause it to serve its func-

tion in energy and heat-production. The case of Dr. William Richardson, who insisted that he was cured by persisting in exercise by walking and bathing, notwithstanding an intense disinclination to muscular effort, should be borne in mind.[1] Massage for those who cannot exercise serves the same end to a less degree. The diabetic should occupy well-ventilated and well-aired rooms, and bathing and friction should be practised daily.

The Treatment of the Complications.—The complications of diabetes are, as a rule, so largely dependent on the malnutrition which is the result of sugar in the blood that the treatment most conducive to their cure is that calculated to cure the disease itself. Furunculosis, carbuncle and gangrene, constipation, pruritus, diabetic coma, and neuritis are the principal conditions which call for further treatment, while that for the original disease is to be carried out with increased energy.

The furuncle and carbuncle call for the usual antiseptic surgical treatment for these conditions in addition to supporting measures, with precautions against too much operative interference. Amputation with the knife should not be done for gangrene. Antiseptic dressings should be persistently used. Chloroform should be especially avoided for inducing anæsthesia, as the heart, already debilitated, falls a ready victim to depressing influence. Ether and morphine should be relied on.

Constipation is sometimes one of the most troublesome complications of diabetes, and I have long observed that cases attended with constipation are the most difficult to relieve, while those associated with a tendency to looseness of the bowels are more amenable to treatment. In constipated cases ordinary doses fail. I have also noticed that purgatives supposed to act upon the liver, such as calomel, blue mass, and podophyllin, followed by salines, are the most efficient, and act favorably, too, on the glycosuria. The small doses often repeated are not so satisfactory as full doses, say 10 grains (.66 gram) of calomel or blue mass at night, followed by a saline in the morning. Podophyllin in $\frac{1}{4}$ grain (0.165 gram) doses combined with colocynth and aloes, with a little belladonna, makes a good nightly pill, which may be substituted now and then by the mercurials mentioned. Enemas have often to be used to help out the aperient, and must be carried high up and persevered in.

Pruritus and associated eczema are among the most distressing of symptoms. They demand, first, the most energetic use of the curative treatment for diabetes; next, the observance of the most rigid cleanliness and washing with antiseptic solutions. Then the parts should be dressed with antiseptic gauze skilfully applied and

[1] *Remarks on Diabetes and its Treatment*, by William Richardson, M. A., M. D.

frequently changed. Solutions of carbolic acid, 7 to 10 grains (.46 to .66 grams) to the ounce (30 c.c.) of water, are sometimes useful in allaying the itching until other measures bring about their results; strong solutions of cocaine, 10 to 20 grains (0.6 to 1.3 grams) in an ounce (30 c.c.) of distilled water, may be used.

Diabetic coma once established shows no quarter. Threatened coma may, however, be averted. The patient's system should be drenched with alkaline waters. The French (Celestin's) Vichy, in doses of 8 ounces (240 c.c.) every two hours, should be used. I always order it when I can get it, and it may be rendered more alkaline by adding citrate of potassium in doses of 30 grains (2 grams) to the glass of Vichy. Often coma may be thus arrested. When coma is established, it may be set aside for a time by hypodermoclysis of normal salt solution (0.8 per cent.). The needle is placed in the thigh or buttock, and a quart or more of normal salt solution allowed to run in from the reservoir of a fountain-syringe appropriately suspended for the purpose. After such injection I have seen what others have reported, a wonderful revival of consciousness and intelligence for a time; but for a time only, and I know no one who has secured any more permanent result.

DISEASES OF THE BLOOD.

By RALPH STOCKMAN, M. D., F. R. C. P. Edin.

The subject of diseases of the blood is an exceedingly interesting one, and is deserving of careful study by the practical physician. The broad clinical features of the different morbid conditions have been long clearly laid down and for the most part receive general acceptance, while the grosser and more easily recognized pathological changes in the blood and other organs have been described with accuracy and detail. It is when we come to deal more especially with the etiology of these diseases that our knowledge is found to be disappointingly vague and meagre, and in many, if not in most of them, it gives us few or even no indications for satisfactory treatment. In fact, our treatment of most of these conditions is still in the empirical and experimental stages.

During the past few years our knowledge has undoubtedly been considerably extended by a number of clinical and experimental observations, yet these have dealt chiefly with details, and for the most part do not represent any very striking or radical advances.

It is perhaps desirable to say here a word about the present classification of the so-called "blood diseases." In this category authors have somewhat arbitrarily included many conditions which produce anæmia, but which manifestly only affect the blood as a secondary consequence of the original disease, while affections involving the lymphatic glands and other parts of the hæmatopoietic system are also generally described under this heading. It is plain that many of the conditions, such as melanæmia for instance, are directly dependent on malaria or other disease, and that treatment directed solely to improve the blood will be quite inadequate until the *origo et fons mali* has been successfully dealt with. In the same way Addison's disease has been gathered into the list of diseases of the blood, although we have no authority for doing so from our scanty knowledge of the purposes which the suprarenal bodies subserve in the animal economy. Further, it is at present the custom for systematic writers to divide anæmias into two classes—primary or idiopathic and secondary—and this is admittedly to a certain extent a convenient clinical distinction, but it is doubtful if it is a scientifically accurate one. We know definitely that anæmia follows cancer,

phthisis, lead-poisoning, hæmorrhage, etc., but we do not know definitely if in any single class of anæmias the blood is the seat of primary affection. In fact, as our knowledge advances and their causes become revealed, the so-called primary anæmias are gradually disappearing. It is certainly a misnomer to call such cases idiopathic, and if we use this term at all we should do so on the clear understanding that as yet we have simply failed to recognize the cause, and not that no cause for the condition exists.

The outcome of these considerations clearly is that the term "diseases of the blood" is rather a convenient designation than a scientific classification, and that it is at present made to include a somewhat heterogeneous collection of morbid conditions, some of which are very ill understood. But while admitting that the generally accepted classification is unsatisfactory, it is evident that it would be premature and useless to attempt to classify these diseases more accurately until our knowledge has been considerably extended. It would probably be best provisionally to designate them as "diseases affecting the hæmatopoietic system," which does not tie one down to any theory and is sufficiently comprehensive to include not only all the elements of the blood itself, but also the glands and tissues which are more directly concerned in its manufacture and maintenance in a healthy condition.

CHLOROSIS.

In all cases of chlorotic anæmia the amount of hæmoglobin and therefore of iron in the red blood-corpuscles is seriously diminished. It may even reach as low as 20 per cent. on Gowers' hæmoglobinometer scale, but such a diminution is decidedly rare, from 30 to 50 per cent. being much more commonly found. The red corpuscles may be normal in number, but any number down to two millions per cubic millimetre as recognized by the hæmacytometer is not unusual. The following table shows the results which I obtained from the examination of 61 cases, all occurring in young women:[1]

Number of patients.	Number of red corpuscles per c.mm.	Range of Hb.	Average of Hb per case.
6	4½ to 5 millions.	46–66 per cent.	52.6 per cent.
9	4 to 4½ "	30–60 "	44.8 "
11	3½ to 4 "	35–54 "	42.7 "
15	3 to 3½ "	22–44 "	33.2 "
10	2½ to 3 "	30–48 "	35.7 "
8	2 to 2½ "	20–46 "	31.6 "
2	1½ to 2 "	25–28 "	26.5 "

[1] *Edinburgh Medical Journal*, Nov., 1895.

The alterations in form of the corpuscles are usually, but not always, slight, and the blood-serum is not at all deteriorated either as regards its solid or liquid constituents.

This condition of the blood cannot be regarded, however, as absolutely distinctive of chlorosis, seeing that it is found in other forms of anæmia and notably during recovery from hæmorrhage. Indeed, one cannot say definitely that any one clinical feature is pathognomonic of chlorosis, but when we find blood-changes of this character occurring in young women who still remain plump, and yet suffer from pallor, and from more or less marked cardiac, digestive, and menstrual disturbances, the whole forms a distinctly outstanding clinical picture which is one of the most familiar to physicians.

Etiology.—The etiology of chlorosis is so closely bound up with its successful treatment that a somewhat full consideration of this may not be out of place. It is now generally admitted that chlorotic anæmia does not arise from excessive destruction of red corpuscles, but is due to deficient formation or to actual loss of blood. Sir Andrew Clark and others have held that dyspepsia, and especially constipation, give rise to ptomaïnes in the intestinal canal, which, becoming absorbed, break down the blood-corpuscles. But, apart from the fact that many chlorotics do not suffer especially from constipation, the pale color of the urine and fæces indicate that fewer red corpuscles are being disintegrated than in healthy persons, while exact researches have demonstrated the absence of any special sepsis in the alimentary canal. Many other causes have been blamed, such as absence of light and fresh air, overwork, especially under bad hygienic conditions, all kinds of depressing and unhealthy emotions, indigestion, excessive or otherwise faulty menstruation, tight-lacing, etc. Most of these, however, must be regarded as predisposing rather than direct causes, and, as the result of the investigation of a large number of cases, I have come to the conclusion that the *direct* causes of chlorosis may be reduced to two, namely, insufficient supply of iron in the food, and loss of iron from the body by menstrual or other bleeding. Without doubt the onset of puberty and the consequent strain thereafter thrown on the body for some years by rapid growth and development are powerful factors in determining the deleterious effect of these influences on the red blood-corpuscles. A certain number of cases undoubtedly are met with in which there has never been any unusual menstrual loss and in which the amount of food taken is satisfactory, but in these even normal conditions probably overstrain the rapidly growing organism.

Lloyd Jones[1] holds that the changes in the blood seen in chlorosis are simply an exaggeration of what normally occurs at puberty in

[1] *Chlorosis*, London, 1897.

girls, at which time, he says, the specific gravity of the whole blood falls, the fall being especially due to deficiency in hæmoglobin. These changes do not occur, he states, in the blood of boys, and hence their immunity from anæmia at an age when it tends specially to affect the other sex. He fails to explain, however, why this normal physiological process should go on to a pathological extent in some cases and not in others, and why chlorotic anæmia should often occur later in life.

Dr. Frederick Taylor has justly remarked that for any theory of the cause of chlorosis to be satisfactory, it must take into consideration and account for its overwhelming preponderance in the female sex and at or about the age of puberty. It seems to me that the following considerations fulfil the conditions: In women, and especially in young women, the number of red blood-corpuscles and the amount of hæmoglobin is considerably less than in men, and therefore the blood is less able to bear any extra strain thrown upon it. That such a strain occurs at puberty there can be no doubt, for not only the blood but the whole organism suffers in its nutrition at this epoch. Primary digestion is usually much interfered with, constipation is common and often very severe, while surprisingly little food is consumed in many cases, and all this while the girl is growing fast. From analyses of the daily dietaries of healthy men and women I have found that the amount of iron ingested equals on an average 8 to 10 milligrammes (about $\frac{1}{8}$ to $\frac{1}{6}$ of a grain) per day, while the analyses of five days' food of three chlorotic girls showed that they were ingesting only from 3.2 down to 1.2 milligrammes (about $\frac{1}{20}$ to $\frac{1}{50}$ of a grain) of iron per day. It has never been determined how much iron chlorotic women excrete by the bowel and kidneys, but healthy persons lose by these channels at least about 6 milligrammes daily. It is, therefore, at once apparent that with a loss of iron from the body which at all approaches the normal, and with such an insufficient intake, the result will be that the organism gradually becomes drained of its iron and there remains little or none from which new hæmoglobin can be formed. Of course in these cases the food will always supply a certain amount, but this is obviously too little to maintain the hæmoglobin at a healthy level.

That by menstruation a relatively large amount of iron may be lost is also made obvious by a very simple calculation: In 100 grammes of healthy blood there are about 45 milligrammes of iron. Now, during a menstrual period, say about six ounces of blood are lost; this means about 90 milligrammes of iron—that is, as much iron as a healthy person ingests in food during nine or ten days. In healthy women there are reserves of iron in the liver and spleen

[1] *British Medical Journal*, 1895, ii.; *Journal of Physiology*, 1895, xviii., 1897, xxi.

which can be at once drawn on to supply this demand, and hence the loss is easily borne and soon made up, but the anæmic have no such reserves, and thus each period increases their lack of iron and hæmoglobin. It is certain, therefore, that loss of blood not only directly produces anæmia, but also prevents speedy recovery from it by draining off the reserves of iron in the body. As a corollary the amenorrhœa of chlorosis must be regarded as protective and beneficial, and as a result, not a cause, of the anæmia. Chlorosis, therefore, is most commonly seen in young girls, and shortly after puberty, because, to start with, their blood is comparatively poor in corpuscles and hæmoglobin, and an excessive strain is often thrown upon it by menstruation and rapid general development.

To summarize: All the causes of chlorosis, ordinarily enumerated, may probably be reduced to two *direct* causes:

(1) *Excessive menstrual loss*, or (much less frequently) other blood-loss. This may be relative, that is, too much for a weakly or rapidly growing organism to bear, or it may be actually large.

(2) *Insufficient ingestion of iron* with the food. Anything which diminishes the appetite diminishes the consumption of iron; therefore dyspepsia, constipation, unhealthy surroundings, mental depression, etc., all predispose to anæmia by lessening the amount of food consumed. In many cases both causes are combined. The anæmia of boys and of non-menstruating girls can be explained in this manner also.

Treatment of Chlorosis.

Administration of Iron.—Clinical experience has proven abundantly that the chief remedial measure in chlorosis is the administration of iron. Any one of the ordinarily used preparations suffices, as they can all be absorbed, and in the present state of our knowledge no one preparation can be definitely put before another merely as regards iron.

The state of the stomach, therefore, must be our chief consideration in choosing the form of iron to be used in any particular case. If, as so often happens, there is gastric irritability, the mildest and least astringent preparations do best, such as reduced iron, ferrous carbonate in one form or another, or one of the double salts, while the oxalate and lactate are also suitable. The protochloride and sulphate, although very largely used, are more irritating, and the ferric salts are both more irritating and more astringent than any of the others. Large doses are generally held to act more rapidly and efficiently than small, but in my opinion too much has been made of this, and, further, they tend to seriously disarrange digestion. No doubt, if a very large quantity of iron is present in the alimentary canal, the

probabilities are that rather more of it is absorbed than if the quantity were small, but this is more than counterbalanced by the attending disturbances of primary digestion. I generally give one grain of reduced iron made into a pill with a small amount of extract of gentian thrice daily after food, and I find that it is invariably well borne by the stomach, does not tend to cause constipation, and acts quite as quickly and efficiently as much larger doses. Two grains twice daily after meals is just as efficient and lessens the number of times of taking medicine.

There has been much discussion as to the mode of action of iron, some authorities holding that none of the metal is absorbed, and that it simply stimulates gastro-intestinal digestion so that more food is consumed and the iron of the blood is made up from the organically combined iron contained in our dietary. Bunge and others believe that iron in the bowel simply prevents the sulphides there present from separating out the iron of the food and thereby rendering it unabsorbable; but I have shown that sulphide of iron is as efficient in curing chlorosis as other iron preparations are, while bismuth and manganese, which are just as capable of absorbing sulphuretted hydrogen as iron is, have no curative effect. If Bunge's theory were correct, these and other drugs should act quite as beneficially as iron undoubtedly does, but they do not. Macallum[1] and Hall[2] have now traced in animals, and Hofmann[3] in man, the absorption of inorganic iron salts by the mucous membrane of the bowel, and this should forever set the question at rest. We have no knowledge of the amount actually absorbed from the human intestinal canal when iron is given medicinally, but even under the most advantageous circumstances it is always small, and probably does not exceed some milligrammes per day. After absorption it seems to be stored up in the liver and to be converted into organic compounds resembling hæmoglobin in constitution, but more simple; and these ultimately form the hæmoglobin of the red blood-corpuscles. The amount thus stored in the liver I found in healthy organs to vary from 0.182 to 0.310 gramme (about $2\frac{7}{10}$ to $4\frac{2}{5}$ grains) metallic iron, and as Bunge reckons the total iron present in the body of an adult at 2.5 grammes (38 grains), the liver is seen to contain a not inconsiderable proportion of the whole. The iron of the liver is, however, a very varying quantity.

From a practical point of view it seems hardly necessary to say much about the hypodermic administration of iron, as the cases are very few in which the drug cannot be tolerated by the stomach, and

[1] *Journal of Physiology*, 1894, xvi.; 1898, xxii.
[2] *Archiv für Anat. und Physiol.*, 1894, 1896.
[3] *Virchow's Archiv*, 1898, 151.

the results of subcutaneous medication are in no way superior to the commoner method. Rosenthal, Luton, Da Costa, and many others have reported cases of successful treatment. I myself have treated four patients in this way, administering once daily a dose of the citrate of iron and sodium equal to $\frac{1}{4}$ or $\frac{1}{2}$ grain of metallic iron. Recovery took place in a perfectly satisfactory manner, but not more quickly than when larger doses are given by the stomach. Solution of ferrous citrate, various so-called peptonates and albuminates of iron, solution of dialyzed iron or other preparations have all been given in this way, but no preparation thoroughly satisfactory for hypodermic use has yet been proposed.[1] Whatever solution is used ought to be perfectly neutral, as little astringent as possible, and should be injected into the deep tissues of the back. If these precautions be taken no pain or discomfort results, but not more than $\frac{1}{2}$ grain metallic iron should be given at a dose.

Iron can also be given with success *per rectum*. The best preparation is a thoroughly neutral and unirritating combination with albumin, and this may be given in large doses.

Hæmol and *hæmogallol* are two preparations made from blood, which have been proposed by Professor Kobert as being very readily absorbed and utilized, but my clinical experience has been that they are almost useless. *Ferratin*, a preparation made from the liver and containing about 6 per cent. of iron, is a little better than these, but by no means equal to the ordinary inorganic compounds. Such organic preparations contain too little iron to be of much value, and the same is true of the various wines and other similar products of pharmaceutical enterprise which are so much advertised.

Blood and various preparations made from it I have never found of much value, as they are difficult to digest and do not contain a sufficient quantity of iron.

Manganese, which has a certain reputation as a hæmatinic, I have found to be absolutely useless in chlorosis. I am inclined also to the opinion that arsenic is of little or no value in chlorotic anæmia, although its effect in the anæmia of tubercle and in other forms is beyond dispute. In cases of chlorosis which I have treated with arsenic alone no improvement of the blood ever took place, but recovery immediately began whenever iron was substituted. This has been the experience of other observers also. The fact remains, however, that small doses of arsenic are very largely used as an adjunct to iron, and there is a very general belief that it stimulates blood-formation and hastens recovery.

As regards dietetic measures the greatest care should be taken to

[1] For full information on this subject see J. M. Da Costa, *Therapeutic Gazette*, May, 1896.

[2] *British Medical Journal*, 1893, vol. i.

improve appetite and digestion. Good general surroundings and personal hygiene, along with the treatment of the ever-present dyspepsia or constipation, are of the utmost importance, as thereby the patient gets into the habit of taking large quantities of food and hence ingests sufficient iron. The same is true of country air, spa treatment, hydrotherapy, and massage, all of which are useful adjuncts to the more direct methods of cure. No specific dietetic rules can be laid down applicable to all cases, for the diet must be entirely regulated by the condition of the digestive organs. If gastric digestion is good, then an ordinary mixed diet is most suitable, and it can be modified to suit cases which suffer from constipation. In cases where pain and distention after eating are prominent symptoms the subcarbonate of bismuth, alone or combined with magnesia, should be given in powder or mixture about thirty minutes before meals; if there be want of appetite, rhubarb and sodium bicarbonate along with a bitter should be substituted. If there be severe dyspepsia or gastric ulcer, it is obvious that a dietary and treatment appropriate to these conditions must be prescribed. In all cases, however, iron must be given—for, once a patient is markedly anæmic, the amount of iron furnished even by an abundant dietary can only go a very little way toward providing the supply of that metal necessary for recovery. Say that the blood is deficient in iron to the extent of fifteen grains, it is evident that it will be a very long time before this can be made good from the small amount of surplus iron in an ordinary dietary.

If constipation do not yield to dietetic treatment and gentle abdominal massage, then purgatives must be resorted to; but they should be used as sparingly as possible. Cascara sagrada, nux vomica, confection of senna, aloes, and salines are the best.

Rest in bed is justly held to be an important element for the successful treatment of severer cases of chlorosis. Many patients do best if confined strictly to bed during the first fortnight of treatment, and some recover only after this has been strictly attended to. The most probable explanation seems to be that during complete rest the demand for oxygen is much less, and hence the diminished hæmoglobin can cope with it. The muscles at rest use very little, and hence the supply can be employed almost exclusively for purposes of nutrition, and thereby digestion and general health are improved. Slight cases of chlorosis, however, do best with an open-air life and a moderate amount of exercise. Violent exertion of all kinds should be strictly prohibited, as the strain thrown on the heart is apt to lead to dilatation.

Once the patient is fairly under treatment with iron and other measures there is a rapid improvement in the blood. The corpuscles, if deficient, generally reach the normal standard in about a fortnight

or less, but the hæmoglobin lags far behind, and it takes usually four to six or eight weeks before its maximum is reached. The administration of iron should be continued for some time subsequently.

The value of treatment by purgatives requires perhaps more than a passing reference, seeing that the theory on which it is based has attracted much attention in our profession. In 1805, Hamilton of Edinburgh, conceiving that chlorosis was due to malnutrition consequent on constipation, proposed to use purgatives very largely in its treatment, but a perusal of his work does not convey the impression that he had any very striking success. In 1887, Sir Andrew Clark again brought forward this plan, founded on the theory that the anæmia is due to absorption of decomposition-products from the bowel. He used saline purgatives, but the mixtures which he prescribed contained very large amounts of iron, and hence no conclusions can be drawn from his observations. Besides this, the theory of the etiology of the disease on which his treatment was founded has since been proved erroneous. Further, observations have now been made on many cases which were treated by purgatives alone, and the unanimous verdict of many clinicians is that purgation *per se* has no direct effect in curing the anæmic condition. No one, however, denies its value as a means of general treatment in this as in many other conditions where constipation is often a prominent feature. As regards massage exact observations have been made by J. K. Mitchell, who found that in all forms and grades of anæmia improvement took place in the number of red corpuscles. It was at first transient, but after repeated rubbings for an hour daily becomes permanent. There is a less marked and less constant increase in the hæmoglobin-value. The general toning up of the muscles and circulation tends also to promote recovery.

In very obstinate cases of chlorosis treatment by residence in high altitudes may be recommended. Jourdanet and Paul Bert first drew attention to the effect of diminished barometric pressure in increasing the red corpuscles and hæmoglobin, the increase being evidently compensatory. Viault found that when he ascended from Lima to a point in the Andes about 12,000 feet above sea-level his red corpuscles increased in twenty-three days from 5,000,000 to 8,000,000 per cubic millimetre. The same result has been obtained at Awsa (about 5000 feet), Davos, and elsewhere. Even at an elevation of 600 feet there occurs a slight increase. In healthy persons it begins at once, but does not last long after return to the sea-level. In chlorotics the improvement is often permanent.[1]

Many cases show a tendency to relapse, and hence prophylactic measures assume great importance. Seeing that undue menstrual

[1] *Vide* Schauman and Rosengvist, *Zeitschr. f. klin. Med.*, 1898, 35.

losses and insufficient food are the two great immediate causes of chlorosis, prevention seems simple enough. If the patient be not placed under favorable conditions or remain subject to the causes which originally produced the anæmia, then treatment may be inefficacious or very prolonged. Therefore if the menstruation be relatively or absolutely too abundant, it should be diminished by giving ergot or by other measures. More important still is the cultivation, by exercise and all possible means, of an habitually good appetite and vigorous health, because thereby the blood is kept at a healthy standard.

SPLENIC ANÆMIA.

This is a little-known and ill-understood disease in which anæmia is a prominent symptom. According to Banti the deterioration of the blood is secondary to enlargement of the spleen; Kanthack regarded the splenic hypertrophy as secondary and compensatory in character; while Von Limbeck has suggested that it is the last stage of the severe anæmia of syphilis or rickets. As a matter of fact our knowledge of clinical and pathological data bearing on the condition is as yet much too limited to enable us to come to any satisfactory conclusion as to its cause, but I have seen a case in which acquired syphilis, rickets, and malaria could with certainty be excluded from the patient's previous history. It has also been named "splenic cachexia," "splenic pseudo-leukæmia," "lymphadenoma splenica," and "primary enlargement of the spleen"—*splénomegalie primitive* of some French authors. The name splenic anæmia implies a theory as to the causation of the blood-changes, and is therefore not quite satisfactory, but it may be retained until improved knowledge gives us a right to name this state more appropriately.

This variety of anæmia occurs at all ages, but is apparently most frequent in male adults in early middle life, beginning with gradually increasing weakness and pain in the splenic region. The attacks of pain become more marked and more frequent, the spleen becomes greatly enlarged so as to cause a distinct swelling of the abdomen, and there is pronounced anæmia. Extreme anæmia, with progressive weakness generally ends in death from exhaustion or hæmorrhage. The liver is usually enlarged to a moderate or considerable extent, there are attacks of perisplenitis often accompanied by very severe paroxysms of pain, and the temperature keeps up to about 102° or 103° F. There may be severe dyspepsia, sometimes with constipation, sometimes with profuse dirrhœa. The patient is sometimes cachectic, but may have a fairly well-nourished and healthy look, and may complain only of the "lump" in the left side. Hæmorrhages are common from the nose, stomach, bowel, and gums, and

also occur into the retina, the spleen, and other viscera. The disease is generally progressive from bad to worse and runs its course in from one to four or five years, but some cases live much longer without presenting any very marked change.

The red blood-corpuscles may be diminished one-half or more, and the hæmoglobin falls in about an equal proportion; the red disks are rarely misshapen and there is no leucocytosis.

After death the fibrous trabeculæ of the spleen are seen to be much hypertrophied, there is atrophy of the Malpighian bodies, and the organ may weigh as much as six pounds. The liver has been found normal, but usually there is a large increase in its fibrous tissue and also in size and weight. As regards the amount of iron found in these organs different cases have yielded different results; in some no reaction to the ordinary tests for iron has been obtained, while in others there has been a decided increase, but no exact analytical estimations are recorded. Little also is known of the changes in the bone-marrow, but they, too, seem to be inconstant.

Banti thinks the condition may be a purely splenic form of pseudo-leukæmia (Hodgkin's disease), and that the spleen having become enlarged destroys the red corpuscles. This view, however, seems to be negatived by the fact that the iron arising from the destroyed corpuscles may be quite absent from the spleen and liver. Neither can the changes in the blood and nutrition be due to abolition of the functions of the spleen, as it is well known that men can live in good health after excision of that organ.

In a treatise dealing specially with the therapeutical aspects of disease some apology may be considered necessary for dwelling at such length on pathology and symptoms, but my excuse must be that the condition is at present little known to the profession generally, and that, when the attention of a wider circle has been drawn to it, advances in treatment may be confidently expected to follow.

Hitherto the results of treatment have been extremely disappointing. Arsenic, after a fair trial in a number of cases, has been almost unanimously pronounced to have practically no effect either in curing the disease or in arresting its course. The same is true of other drugs such as iron, quinine, ergot, and potassium iodide. Taylor, however, states that he has seen temporary improvement follow on the simultaneous administration of arsenic, potassium iodide, and oxygen gas to the amount of 30 litres daily. Splenectomy seems to offer the best chance of saving life. In several cases the patient has survived excision of an enlarged spleen, but owing to the disease being little known and to meagreness of description it is difficult to judge if these were real cases of splenic anæmia. Further, it is often difficult to gather from the published accounts how long the patient lived after

recovery from the operation, and this is a matter of great importance in judging of the ultimate value of the operation, as splenic anæmia is often a very chronic disease and the patient might have lived just as long without undergoing operation.

Spanton has collected 38 cases of "hypertrophy" of the spleen in which splenectomy was performed. Of these 18 recovered, but it is impossible to say whether they were all cases of splenic anæmia.

PERNICIOUS ANÆMIA.

A SATISFACTORY consideration of the therapeutics of pernicious anæmia is rendered very difficult by the complete absence of agreement as to what really constitutes the disease. Regarding the clinical features there can be no dispute, as the excessive anæmia, the yellowish tinge of the skin, the extreme muscular and cardiac debility, the dyspepsia, and irregular febrile attacks with the tendency to hæmorrhages, enable one to diagnose the case almost at a glance. The hæmoglobin may be reduced to 10 per cent. and the red blood-corpuscles to 500,000 per cubic millimetre, but they are usually about double these numbers when the patient first applies for advice. There are marked alterations in the shape of the red disks, and there may be many microcytes and a few nucleated red cells. Great stress is usually put on the fact that the red corpuscles are diminished proportionately to the hæmoglobin, and this is often laid down as an essential point of difference between chlorosis and pernicious anæmia. I am inclined to think, however, that too much importance has been attached to it, and that this proportion is present in all cases of very severe anæmia from whatever cause.

Clinicians are now agreed that this profound degree of anæmia may be brought on by many conditions, and hence many hold that it is not a disease by itself, "a morbid entity," but is simply an extreme deterioration of the blood following on any one of numerous and varied preceding states. Certainly, whatever be the cause, or whether no definite cause be found, the symptoms are practically identical in all cases. Cases have been reported in which it has followed an atrophy of the gastric mucous membrane, ulceration of the intestinal canal, diarrhœa, severe hæmorrhage, pregnancy, lactation, typhoid and other fevers, malaria, syphilis, chlorosis, and jaundice. Typical clinical examples have been described where, post mortem, malignant disease of the abdominal viscera or of the bones was found to be present, and it is now established that the clinical features of so-called pernicious anæmia may be produced in every detail by intestinal worms such as the *Bothriocephalus latus* and *Anchylostoma duodenale*. The latter certainly induces the anæmia by direct withdrawal of blood,

[1] Stockman, *British Medical Journal*, 1895, vol. i.

and hence acts like hemorrhage; but how the former impoverishes the blood and why it only does so in certain cases is not very clear, although its action seems connected with the production of a specific poison by the parasite.

On the other hand, many physicians have a totally different conception of what should be understood by the term pernicious anæmia, and hold that true cases are not secondary to other conditions. Dr. Pye-Smith insists that cases of extreme anæmia after pregnancy, diarrhœa, hæmorrhage, etc., are not true cases of the "idiopathic anæmia of Addison" where no cause is discoverable; and Dr. Hale White says: "For the case to be an example of the disease described by Addison it is essential that there should not be present any of the usual causes or concomitants of the anæmic state." They wish, in fact, to call "pernicious" or "idiopathic," only those cases in which we are ignorant of the cause, assuming that in these it is a primary blood-disease, and ignoring the fact that no disease can, properly speaking, be called idiopathic. Such a term simply implies that we do not know the cause, and since Addison's time we have discovered the cause in many cases which he might have classed as idiopathic.

Dr. W. Hunter has advanced a theory which has obtained wide support. He holds that pernicious anæmia is a distinct disease due to excessive blood-destruction, and that its most constant pathological feature is a large excess of iron in the liver, which distinguishes it from all other varieties of anæmia. He believes that the red blood-corpuscles are broken down by decomposition-products formed in the alimentary canal and absorbed into the portal circulation, the excess of iron in the liver being derived from the débris. Cases occur, however, in which there is no excess of iron pigment in the liver.[1] Lépine holds a position somewhere between the two extremes in believing that the condition follows on causes generally recognized as predisposing to anæmia, but that there is superadded an individual weakness in blood-forming power which determines the great extent to which it progresses. Eichhorst, on the other hand, holds the opinion that some cases are "primary idiopathic" or "essential," and others secondary to exhausting conditions or diseases.

From the present evidence it seems most probable that pernicious anæmia usually follows loss of blood or well-recognized debilitating causes of one kind or another. The cause is, however, in many cases undetected, but these can hardly be regarded as idiopathic in origin. Further, it is improbable that a hypothetical wholesale destruction of red blood-corpuscles by the liver-cells or by a ptomaïne or ferment is the cause of the condition. Debilitating conditions are

[1] Stockman, *Edinburgh Hospital Reports*, 1896, vol. iv.; *British Medical Journal*, 1896, i. 1077.

common enough, yet they are comparatively seldom followed by extreme anæmia, and we are as yet, in a broad sense, quite ignorant of the reasons for its occurrence in certain cases. In all cases it is the intense bloodlessness which is the cardinal feature of the disease clinically. The debility, breathlessness, yellow color of the skin, and excess of iron in the liver are of secondary import. In fact, I have shown that many cases of fatal anæmia present no excess of iron in the liver or spleen, and that in cases where iron pigment exists in large amount in these organs it may also be found in the brain, kidney, fatty tissue, etc., which can hardly be supposed to have any blood-destroying function. Whether this iron pigment arises from the hæmoglobin of internal hæmorrhages, or from red corpuscles which have been actively destroyed somewhere in the body is still in dispute.

Treatment.—Seeing that so many widely different causes may give rise to extreme and frequently fatal anæmia, our first endeavor should be to treat any case on etiological principles. Unfortunately this is only sometimes possible, as the causes underlying the anæmia are often discoverable only after death, or are not revealed even by the autopsy. To this ignorance is no doubt attributable in some degree at least the frequent non-success of treatment, while in addition many cases apply for advice only when they have reached a high degree of bloodlessness and when the extreme debility, gastric dyspepsia, and liability to diarrhœa stand greatly in the way of successful treatment. Although Habershon says that many patients in the early stage recover under iron and general tonic treatment, yet experience forces us to admit that in the ordinary run of cases the prognosis is extremely grave. Reliable statistics as to permanent cures are lacking, but Quincke reports 7 cures out of 21 cases, Müller 3 out of 44, and Pye-Smith 20 out of 110. Many of these so-called cures were certainly not permanent, as hospital cases especially are apt to drift out of ken and die without any information being communicated to their doctor. It is a common enough experience to have a case which recovers for some months or even for a year or two and then relapses and dies ; in fact, some few go on in this way for many years. It is known, however, that a few cases have made permanent recoveries, and if we include those cases due to intestinal parasites the number grows very considerably.

Cases secondary to malignant disease, to chronic gastric atrophy, or other necessarily fatal conditions may be dismissed at once as hopeless. Specific lines of treatment cannot be laid down for these : the patients must be treated on general principles, and the symptoms as they arise ameliorated as far as possible. Bitters and acids may be given to assist digestion, while strict attention to the dietary and the

administration of moderate quantities of wine certainly add greatly to the patient's comfort.

Wherever hæmorrhages from piles or from mucous surfaces are present these must be carefully and at once controlled, and so must diarrhœa, which seems to be specially exhausting and often precipitates the fatal termination. The diarrhœa is often most obstinate, but the best means of stopping it consist in putting the patient on a diet of boiled or peptonized milk, in giving opiates by the mouth, and opiate enemata. Fifteen minims of laudanum and liquid extract of ergot every six hours often succeed well, but, this failing, large doses of subnitrate of bismuth, solution of per-salts of iron, or other astringent measures may be tried. A history of syphilis or malaria may give us some guidance, but Müller's results with anti-syphilitic treatment are certainly not very encouraging: out of four only one case recovered.

In the anæmia of ankylostomiasis anthelmintic treatment is usually successful. This disease is endemic in Egypt and India, where it is answerable for a very large amount of chronic ill-health, and it has been carried to the Cape, Fiji, Trinidad, and other places by immigrant coolies. Several outbreaks have occurred in Germany, France, and Austria among miners, and in Switzerland and Italy among the navvies engaged in railway-tunnelling. The eggs of the parasite are found in the soil and are swallowed with food. The eggs are present in large numbers in the fæces and are easily recognized under a low power of the microscope, so that diagnosis is easy. The best treatment is by thymol, of which 20 grains dissolved in brandy or other spirit may be given once or oftener. Filix mas may also be used in appropriate doses—one or two drachms of the liquid extract in emulsion. Where the habits and surroundings of the patients are good they almost invariably recover under this treatment, but in coolies, who are filthy in their habits and are often dirt-eaters, deaths are not infrequent. Thus in Fiji, Hirsch reports 26 deaths out of 126 cases treated.

Bothriocephalus anæmia is most common on the shores of the Baltic, but it is probable that other kinds of tape-worm may give rise to fatal anæmia. Formerly all these cases died in spite of arsenic, iron, and other drugs, but now, when the causal connection between the parasite and the anæmia has been recognized deaths are rare, and this should lead us to hope that many other kinds of cases would be equally amenable to treatment if we only knew the cause. Filix mas readily kills the worm, and as soon as the latter is expelled recovery begins, and is usually complete in about six weeks.

Hunter, basing his treatment on the theory of intestinal sepsis, has advocated the use of a farinaceous diet with intestinal antiseptics such as beta-naphthol, but I must confess that I have never seen

much success follow this plan, although mercurials, guaiacol carbonate, and numerous other drugs of the same kind have been used in addition. Nevertheless, Sandoz reports a case due to excessive fermentation in the stomach and intestine, which was cured by persistent lavage, while Jürgensen states that a patient of his recovered after the expulsion of enormous numbers of *Bacterium termo* from the bowel.

Cases which have been brought on by hæmorrhages, hardships, poor feeding, or by unknown causes are best treated by careful and nourishing feeding and by arsenic and iron, combined with complete rest in bed. Arsenic is the drug on which experience has taught us to place most reliance. Its mode of action is not understood, but the most probable explanation is that it stimulates the formation of new corpuscles by the red bone-marrow. It has undoubtedly started many cases toward recovery, although too frequently this is not permanent, and disappointing relapses follow. It is usually given in 5-minim doses of Fowler's solution thrice daily after food, but of course the dose may be varied to suit the case. Iron does not usually make any marked improvement in the blood, and fails to cure or improve the patient's condition. In fact, the failure of iron to effect a cure has often been included in the definition of pernicious anæmia, but we should remember that iron is equally ineffective in the anæmia of such constitutional diseases as cancer and tubercle, and that where it fails it probably does so by not affecting the underlying cause. It is good practice to combine it with arsenic, because if the arsenic increases the formation of red blood-corpuscles it is necessary to supply sufficient iron to provide the necessary hæmoglobin; but not infrequently it disagrees rather seriously, and may therefore do harm on the whole.

Iron given alone, however, has sometimes proved successful, and hence the general pessimistic view of its inutility is probably too extreme. Thus Quincke treated his seven cases of recovery with iron, and cases have been recorded in which arsenic failed to effect any improvement, but in which recovery subsequently took place under iron. It is sometimes very badly borne by the stomach, and in these cases may be given *per rectum*. Administration by subcutaneous injection has not proved more successful than by the mouth.

Phosphorus has been recommended, and occasionally seems to improve the condition of the blood, but on the whole its use has been disappointing.

Bone-marrow was first used by Dr. Dixon Mann,[1] who gave a glycerin extract in three cases of anæmia with asserted good results. Subsequently it was stated by Fraser to have cured a case of per-

[1] *Lancet*, 1894, i, 599.

nicious anæmia whic had made no improvement under iron, arsenic, and salol, but immediately began to recover when three ounces of ox and calf bone-marrow daily were added to the treatment. Barrs has also published a case in which arsenic had failed to effect any improvement, and in which he then administered bone-marrow without any other drug, when complete recovery took place in about two months. Since then several other cases have been reported in which bone-marrow has done good, as well as others in which it has been without effect, but on the whole little confidence in its utility has been established. Whether it be red bone-marrow or yellow it contains mere traces of iron, and the latter consists almost solely of fat. It may, however, possibly contain some active chemical principle which is of advantage in blood-formation, and the fact that glycerin extract is reported to be as efficacious as the marrow itself would, if it be true, lend support to the view. Further clinical and experimental observation is required to settle this question.

Transfusion of blood has very frequently been resorted to with the view of supplying the deficiency of blood-corpuscles. Only the blood of man should be used, as that of other animals is deleterious in many ways. Four to six ounces of blood should be withdrawn from the donor and rapidly mixed with one-third of its bulk of solution of phosphate of sodium made up to the specific gravity of blood-serum (about 1028) and kept at the temperature of blood in the body. This prevents coagulation and enables the mixture to be transferred without risk into one of the large veins of the patient's arm; it should be done deliberately, about thirty minutes being occupied in allowing eight ounces to flow in. Very frequently transfusion produces slight temporary benefit, and in a few cases this has been permanent. Brakenridge[1] has reported five cases in which repeated transfusion was performed, but only one of these recovered, while Affleck has also reported a case which recovered after transfusion. In view of the fact that certain cases have recovered after transfusion it is probably worth trying after other means have failed, but it must not be forgotten that experience has shown its utter uselessness in the large majority of cases. No sufficient explanation of its action in successful cases has ever been given, but it has been suggested that healthy blood may act as an antitoxin in destroying some ferment which is breaking down the blood-corpuscle. Transfusion of saline solutions *per rectum* and intravenously to restore the bulk of the blood has at best only a temporary restorative action.

[1] *Trans. of the Medico-Chirurgical Society of Edinburgh*, 1891–92, ix.

ADDISON'S DISEASE.

Here the most outstanding clinical feature is the peculiar bronzing of the skin which is so characteristic of the disease, but it is preceded and accompanied by a very marked sense of muscular weakness, often of cardiac weakness, and more or less dyspnœa, all of which symptoms sometimes call for a good deal of treatment.

Its usual duration is about one to two years, but from a few weeks to eight years are the extremes in reported cases. Some few cases have apparently recovered, but this must be very exceptional, and speaking practically it runs a fatal course. Death may occur from asthenia, often hastened by severe diarrhœa, or may be due to tubercle or cancer, or some intercurrent complication. After death the suprarenal bodies are found to be involved in some gross lesion—tubercle, cancer, hæmorrhage, external pressure—or may have simply atrophied. In a few cases the semilunar ganglia and nerves in their neighborhood seem to be the seat of the lesion, the glands themselves being apparently healthy. In those cases in which I have examined the blood, both corpuscles and hæmoglobin were up to the normal healthy standard and there was no leucocytosis. The symptoms are directly connected with abolished function of the suprarenal glands, and are now generally held to be due to an inadequate secretion of some substance which is essential to life. This seems to have been proved by an experiment of Abelous and Langlois, who kept animals alive after excision of the glands by injecting an extract made from them. Why the absence of the secretion should cause pigmentation and extreme weakness is quite unknown as yet, although Schäfer and others have found that the extract made from the adrenal bodies of animals stimulates the circulation and nutrition.

The theory has also been propounded that the function of the capsules is to excrete some toxic substance from the blood, but this explanation seems to be completely discredited by the above-mentioned experiment, in which the administration of the glands averted death after their excision.

Treatment.—Cases due to tubercle, cancer, etc. are necessarily fatal. Arsenic has hitherto been the drug most relied on, but I cannot say that much benefit has ever been recorded from its use. Preparations made from the suprarenal bodies of sheep have been tried, and not entirely without success, although we have not yet anything like sufficient experience to enable us to judge of the value of such treatment. Oliver has treated two cases with suprarenal extract by the mouth, and the patient gained weight, became less pigmented and free from dyspeptic symptoms. Rolleston and others have reported similar results, but as yet there has not been a case of complete cure.

I have had an opportunity of treating three cases with the suprarenal capsules of the sheep. I used the fresh glands and gave them minced and raw, my reason for so doing being that there is no means of testing the genuineness of the various extracts and dried preparations which are on the market, and no means of knowing how much, if any, of the active principles is contained in them. They agreed perfectly well and were taken without any trouble spread on bread and butter.

Two of my cases showed no improvement whatever and at the post-mortem examinations were found to have extensive tubercular disease of the glands.

The third case was a well-built, finely developed lad, eighteen years of age, with no signs of tubercular or other constitutional affection. He presented the classical symptoms of the disease, and dated his illness from six months previously, when he had begun to feel very weak and had noticed the bronzing of his skin. Some time before this he had fallen from a height on to a plank which caught him in the small of the back and strained it severely, but he recovered in a few weeks. Otherwise there is nothing of interest in the history. He got first two, then three, and then six sheep's capsules daily, without experiencing any unpleasant subjective symptoms. In six weeks there could be no doubt as to the improvement—he was slightly less brown, but was much stronger and had gained four pounds in weight. In ten weeks the improvement was more marked, when he was put on a glycerin extract. Two years later he was reported as doing an ordinary day's work, and although somewhat whiter, was still a good deal pigmented. Since then I have lost trace of him. A curious point is that after he first got strong enough to work he omitted taking the suprarenal extract, and in a very short time felt ill and weak again. I am inclined to regard this case as one of atrophy of the suprarenal bodies, possibly following on the injury to his back.

For the cardiac weakness and dyspepsia heart tonics, stimulants, and the ordinary routine treatment of such conditions is all that can be done.

HÆMOPHILIA.

Little, unfortunately, can be added to what has been previously said in this System regarding the treatment of the constitutional tendency to bleeding. Some observations of A. E. Wright,[1] although very incomplete, may be adverted to as indicating a possible method of ameliorating the condition, although, being constitutional and hereditary, it must be extremely doubtful if it is susceptible to

[1] *British Medical Journal*, 1893, ii.

curative treatment. In a case of hæmophilia he observed that blood withdrawn into the capillary tubes took nine or ten minutes to coagulate as compared with two and one-half to five minutes in the healthy subject. In both the blood was found to coagulate much more rapidly if calcium chloride solution in varying strengths was added to it outside the body. He accordingly administered 15 grains of calcium chloride thrice daily and found that on the two succeeding days the blood coagulated much more rapidly. On the third day, however, the coagulation time had increased very considerably, and owing to other circumstances the observations were discontinued. Wright states, that in recurring epistaxis and in hæmoptysis the tendency to bleed is much lessened by the internal administration of calcium chloride; but other observers have failed to produce an impression by its long-continued use.

It is always difficult to judge of the real value of drugs in hæmorrhage owing to the tendency of bleeding to stop spontaneously, but, quite apart from this, Wright's observations stand greatly in need of confirmation.

THE PRESENT TREATMENT OF SYPHILIS.

By EDWARD MARTIN, M. D.

When and How should Syphilis be Treated Constitutionally?

In recent years those best versed in syphilology have differed in regard to the best time for beginning the constitutional treatment of syphilis. Doubtless, the weight of authority is in favor of withholding specific treatment until general adenopathy or secondary eruptions on the skin or mucous membrane appear. The reason for thus withholding treatment is either that the diagnosis of syphilis can be established beyond doubt only by adenopathy or the syphilides, or that the disease does not reach that stage in its evolution which is most favorably influenced by the exhibition of specific medicament till symptoms of the secondary period have developed.

It is clear that those who do not believe in giving mercury till the diagnosis of syphilis is absolutely established will, save in exceptional cases, be compelled to wait for the secondary eruption, since it is now universally conceded that the most typical local sore may not be syphilitic in nature, or at least may never be followed by other manifestations of the disease.

In direct opposition to the practice of waiting for a certain diagnosis, there are many who urge that treatment should be inaugurated the moment a probable diagnosis is established. The theoretical reasons for this plan of action seem to me conclusive, and, in so far as practical results are concerned, I believe them to prove that the disease is most certainly, easily, and permanently cured by an active, intelligently directed treatment, begun early and long continued.

It is generally conceded that syphilis is a microbian disease; that it enters the system at one point, multiplies there, and finally involves the entire organism; that its effects are counteracted and its virus weakened and ultimately destroyed by mercury.

These facts being true, it seems difficult to understand what reason there should be for delay in the exhibition of the specific drug after diagnosis is once fully confirmed; hence the treatment should be instituted as soon as a chancre is observed.

The main difficulty lies in deciding whether or not a given sore is

a chancre. I have already said that a positive diagnosis of chancre cannot be made; if, however, a genital sore is single, is of more than fifteen days' incubation, becomes indurated in the course of a week, and produces a typical non-inflammatory polyglandular inguinal enlargement, in at least nine cases out of ten such a sore is a chancre. In a few cases, even under such circumstances, secondaries fail to develop either at the regular time or at a subsequent period, and we have been in the habit of regarding such sores as non-specific. This is not necessarily true. Syphilis inoculated upon a resistant system may produce a chancre and no other lesions till years afterward, when tertiary lesions may develop. It is, however, true that some few non-syphilitic sores may simulate chancre.

The strongest argument against early treatment of syphilis is, then, based on the ground of this uncertainty of diagnosis, since it is held that by beginning treatment at an early stage the development of the secondaries is prevented, or at least always retarded, and that neither the surgeon nor the patient can ever be quite sure that syphilis is really present. It is also maintained that as a result of this early treatment the secondaries are irregular and unusually severe.

It is quite true that the administration of mercury during the primary period will almost certainly delay the secondaries, and will make them atypical, at least in regard to their time of eruption. It is, however, by no means proven that lesions when they do occur are more than ordinarily severe. This assertion is made on entirely insufficient evidence, and, as far as my own experience is concerned, is utterly unfounded. It is only fair to state that this point must be settled by clinical study of a large number of cases extending through both the secondary and tertiary periods of syphilis. Such an adequate study has not yet been recorded.

If the practitioner, following the teaching of many of our most eminent and experienced syphilologists, decides to withhold specific treatment until the diagnosis of syphilis is absolutely corroborated by the appearance of secondary lesions, he will do well not to wait for general adenopathy or the eruption upon the skin or mucous membrane, since these are not the first unmistakable signs of constitutional involvement; but, rather, he will institute from the time syphilis is suspected a series of examinations of the blood. If, without otherwise obvious cause, there is a pronounced decrease in hæmoglobin and a moderate increase in the number of the white corpuscles, this, together with the chancre, is sufficiently indicative of syphilis to justify positive diagnosis, and, since it precedes by one or two weeks the development of other secondaries, enables the practitioner to institute a specific treatment this much earlier. It is worthy of note that this anæmia does not invariably develop; hence when the blood remains

normal it will be necessary to wait for adenopathy, exanthemata, or other characteristic early manifestations of the disease.

I would urge, however, that the constitutional treatment of syphilis be begun the moment a probable diagnosis is formulated. As a result of this practice it is possible that two or three patients in the hundred may receive a prolonged mercurial course although their sores are not specific. In the remainder the disease will be combated practically from its incipiency, and lesions of the secondary or tertiary stage will not develop. This early treatment is a valuable means of confirming the diagnosis, since the rapid disappearance of induration, the healing of ulceration, and the lessening of inguinal enlargement under an active mercurial course are not likely to occur except the sore be syphilitic.

Excision of the Chancre.—The treatment of the chancre is a matter of considerable importance if the doctrine of a specific germ as the cause of syphilis is accepted. The local sore represents the seat of entrance of the germ. At this place it multiplies, and from it is distributed through the system. Prompt excision, destruction, or disinfection of this infecting focus seems as reasonable as would a similar procedure in the case of an ordinary poisoned wound. Experience has shown that excision, even if performed at the earliest period, does not necessarily prevent the development of constitutional syphilis, possibly never accomplishes this end, though there are many recorded cases which apparently prove that the disease in a small percentage of cases is prevented. Even though the procedure does not succeed in preventing the development of syphilis, it is reasonable to believe that by removing the original focus of infection the dose of the virus is lessened, and thus the effect upon the system is rendered less severe.

As for the practical application of the general principle of excision or destruction of a chancre, when the patient presents himself with a sore which has developed more than fifteen days after exposure, and which is chancrous in its mode of onset, if seen early, or in its development if seen after some days, the infiltrated and ulcerated tissue should be immediately removed or destroyed.

This treatment is even more imperatively indicated if by confrontation the diagnosis of syphilis can be more positively established. If the sore is on the prepuce, particularly about the preputial orifice, circumcision should be advised, since thus there is a removal of tissue wide of the infiltrated area. When the glans is affected excision followed by cauterization is indicated. If such excision and cauterization would imply mutilation of the glans so great as seriously to interfere with function, the operation should of course not be performed. When the lesion is on the inner layer of the prepuce close

to the coronary sulcus, it may be picked up with a pair of rat-tooth forceps and cut away with scissors.

Schleich's method of infiltration anæsthesia will render all these procedures absolutely painless, obviating the necessity for using ether.

If, because of objection on the part of the patient or for reasons sufficient to the surgeon, excision or destruction of the sore is not attempted, it should be cleansed and dressed in accordance with general surgical principles.

Constitutional Treatment of Syphilis.

At whatever period the treatment of syphilis is begun, the medicine first given is mercury in some one of its forms. This drug, properly administered, is a specific, and we can reasonably expect to definitely and permanently cure nine patients out of ten who conscientiously pursue for four years the course of treatment laid down for them. The patient must, however, not conceive the idea that his cure depends only upon the regular ingestion of the medicine which he is ordered to take. His general health must be brought to its highest degree of perfection, and thus maintained until the poison with which his system is infected is entirely eliminated or destroyed.

Before beginning the mercurial a general physical examination is made; the condition of the kidneys is determined by a number of analyses of the urine; the teeth are put in the best possible condition; the diet is regulated; the general life of the patient is so directed that it may be as hygienic as his surroundings admit; and he is instructed to pay particular attention to the cleanliness of his mouth, using a toothpick and brush after each meal, at night, and in the morning, and employing a mild antiseptic and astringent mouth-wash, such as diluted tincture of myrrh. It is well to have regular examinations of the blood made, since in this way timely warning as to the inadequacy of treatment may be given.

Instructions in regard to general hygiene and medication appropriate to the condition of the patient having been ordered, the questions as to the dosage of mercury and the form in which it shall be given are next to be considered. Patients with foul, decaying teeth are easily salivated. The toxic effects of mercury are still more readily manifested on those with chronic kidney disease. Under such circumstances the drug must be given with extreme caution and must be carefully watched. Occasionally a patient is encountered in whom even a small dose of mercury acts as a virulent poison. This is a matter of idiosyncrasy. With the exceptions just mentioned the drug can be administered safely in the doses hereafter named.

Mercury may be administered by inunction, by the mouth, or by

hypodermic injection. Baths, plasters, and vaporization are also employed as means of causing the absorption of the drug, but are so little used at the present day that I shall not consider them in this article.

Of the three popular methods just mentioned, the safest, most efficient, and least hurtful is that by inunction. The most convenient method—one which is in the majority of cases efficient—is by mouth administration. The method most prompt in its immediate effect, but most painful, most dangerous, and least applicable in private practice is by hypodermic injection.

All these methods have their proper indication, and one should not be used entirely to the exclusion of others. Whenever it is possible, however, I believe that the treatment throughout should be conducted by inunction. When for obvious reasons this method is inapplicable, the mercury should be taken by the mouth. In certain exceptional cases hypodermic injections will prove of the greatest service.

Inunctions.—I have been in the habit of using for inunctions the freshly prepared unguentum hydrargyri or blue ointment of the U. S. Pharmacopœia, undiluted. This is put up in half-drachm or drachm doses, either wrapped in wax-paper or enclosed in cachets. It is well to have the patient bring for inspection the first prescription which he has filled, since rancid ointment is often sold, or that so stiff and hard as to be of little service. When he is thus familiarized with the proper preparation he is not likely subsequently to be deceived.

Taylor recommends the following preparation :

℞.	Mercury,	ʒviij (240.0);
	Lanolin,	ʒxxj (84.0);
	Lard,	ʒxlv (180.0);
	Compound tincture of benzoin,	♏clx (10.0);
	Alcohol,	♏lxxx (5.65).

Triturate the mercury with the tincture and alcohol until coarsely subdivided. Then add portions of the lanolin and lard, and continue the trituration until the mercury is thoroughly subdivided. This ointment is put up in soft gelatin capsules called ovules, which contain either 30 or 60 grains.

Although the term inunction is used in describing this method of treatment, recent research seems to show that absorption is dependent rather upon prolonged contact of the ointment with the skin than upon vigorous friction. It is, moreover, apparent that this prolonged contact is less likely to produce dermatitis than is friction. Hence it is not necessary to instruct the patient to employ vigorous or prolonged rubbing, but rather to direct him to spread the ointment evenly over

a given surface, taking ten to fifteen minutes for this purpose; then to apply over this a woollen garment which should be changed not oftener than once a week.

When the patient is strong, well-nourished, has healthy kidneys and clean teeth, and has exhibited no idiosyncrasy to the drug, treatment may be started by ordering him a drachm of mercurial ointment a day. Anæmic, ill-nourished patients or those with visceral diseases are best treated by much smaller doses at the beginning.

The patient is directed to rub the first drachm of mercury into the left side of the body, using no pressure and simply carrying the hand over the surface of the ribs and the side of the abdomen until the ointment is evenly spread over this surface; this is best done before retiring at night. A flannel undershirt is then put on, over which can be drawn the ordinary night-clothes. The next morning the patient takes a sweat-bath, followed by a cool shower- or sponge-bath, and puts on clean underclothing, the undershirt worn the night before being laid aside for further use. The second night the second drachm is rubbed in on the other side of the body: the same undershirt is again put on. The third night the front of the chest and belly receive the ointment; the fourth night the small of the back, indeed all of the lower dorsal region that can be reached by the two hands; the fifth night, the whole surface of the left arm and shoulder; the sixth night, the corresponding portion of the right arm and shoulder; the seventh night, the left side again. The undershirt which has been worn for seven nights may then be destroyed or washed. In workingmen who are accustomed to wear the same underclothing for a week at a time the morning bath may be omitted, the undershirt being worn night and day.

During this course of treatment the patient should be seen at least every other day by the physician, and should be so instructed that he will recognize the prodromal symptoms of salivation. He should be weighed at least once a week and a record kept of his weight. It must be remembered that under the rubbing treatment salivation may be sudden and severe.

In the absence of symptoms or when under treatment they rapidly disappear inunctions should be given in series of twelve, an interval of six days being allowed to elapse between each series. When symptoms are present and do not yield, or if they develop during the course of inunctions, the quantity of mercury administered must be increased, and the inunctions must be continued without intermission until the symptoms disappear, unless salivation threatens. This may require twenty-four or thirty-six consecutive rubbings of 2 or even 3 drachms of mercury at each dose. When these large doses of the drug are administered the

patient must be kept closely under observation, and the physician must be on the watch not only for the ordinary symptoms of salivation, but for such signs of mercurial intoxication as loss of weight, deterioration in the condition of the blood, loss of appetite, diarrhœa, colicky stools, and albuminuria.

The length of time during which the inunction should be continued, with six days' rest after each series of twelve, is eighteen months. During this period there will have been six months' rest and twelve months of rubbing. The dosage must be most carefully regulated lest by over-zealous treatment the patient suffer more harm than he would from his unchecked disease; this may require the use of much smaller doses than those given. After eighteen months rubbing should be continued in series of twelves with an interval of twelve days' rest between each series, provided there has been no outbreak of symptoms. Under such circumstances a more active course of treatment should be instituted. After three years it is well to continue still another year with a series of twelve rubbings, giving twenty-four days' rest between each series. In the third year moderate doses of iodide of potassium may be serviceable, even in the absence of symptoms. When tertiary symptoms manifest themselves iodides should, as a rule, be given, but not to the exclusion of mercury.

Exceptional cases will be encountered in which small doses of any of the iodides either disorder the stomach, produce acneiform eruptions upon the skin or rapidly diminish the body-weight. Under these circumstances it is best to omit the drug, unless a lesion is developing which by its effect upon a vital or an essentially important organ threatens to shorten the life of the patient or permanently cripple him.

After the fourth year all inunction treatment may be omitted unless subsequently specific symptoms develop. Under such circumstances treatment should be again instituted, and should be continued for at least six months.

Mouth Administration.—The administration of mercury by the mouth is the simplest method of giving the drug, and is the one commonly applicable, since the great majority of patients will not submit to the loss of time, the trouble, and the uncleanliness necessitated by inunction treatment. The physician has little difficulty in inducing his patients to take regularly, for months or years at a time, a medicine which can be carried in the waistcoat-pocket, and which can be ingested without attracting attention to the fact that a course of treatment is being taken.

The administration of mercury by the mouth is open to the objections that it is likely to produce a certain amount of gastro-enteritis,

and that the amount of absorption of the drug depends to a great extent upon the condition of the stomach and intestines, and hence must vary greatly even when the same dose is administered. In spite of these objections, the vast majority of syphilitic patients are treated by internal medication, and the results of this treatment are extremely good.

Of all the various preparations which may be given, I believe the preference should be given to massa hydrargyri, yellow mercurous iodide, and hydrargyrum cum creta.

Since there is nearly always associated with syphilis, at least in its early stages, a more or less pronounced anæmia, iron is advantageously incorporated with the mercury. I have been in the habit of ordering the following prescription:

℞. Ferri carb., gr. ij (0.1);
Mass. hydrarg., gr. ij (0.1).—M.
Ft. pil. No. j.
Sig. Three to six such pills after meals, daily.

It is evident that patients vary greatly in their susceptibility to mercury, in their tolerance of this drug, and that varying quantities of the medicament will be required to subdue the symptoms of constitutional disease even in the same person. With the idea of determining individual susceptibility, and from this as a basis establishing an individual dose of mercury for each patient, Keyes formulated a plan by which he first produces by gradually increasing doses of the drug the prodromal symptoms of salivation. The mercury is then withdrawn till these symptoms entirely disappear, after which the patient is directed to continue throughout the entire course of treatment half the daily dose required to produce such symptoms. When secondary outbreaks occur the dose is increased until all manifestations of the disease disappear.

Absolute reliance cannot be placed on this method of gauging the dose, since individual susceptibility is subject to change, or it may be that absorption of mercury when taken by the mouth is so dependent upon the condition of the gastro-intestinal canal, and consequently varies so greatly at different times, that it is difficult to determine what portion of a dose taken into the stomach is absorbed into the system and is active in combating the disease. Keyes' plan of procedure is, however, an excellent one, and is to be commended as a routine practice.

In determining the quantity of mercury necessary to produce slight toxic effects the symptom of beginning salivation should be taken, rather than of intestinal colic and watery stools. The latter

often denote simply that gastro-enteritis has developed as the result of a local irritating effect of the drug. The urine should always be regularly examined at the beginning of the mercurial course, since the first symptoms of hydrargyrism are sometimes manifested in the forms of albuminuria and cylindruria.

Yellow mercurous iodide is one of the most popular preparations for mouth administration. Belief in its efficiency is perhaps based in part upon the hope that the chemical combination of mercury with iodine may produce the effect of each of these drugs when given separately. In many cases this preparation will be found more serviceable than any other form of mercury. At times it produces loss of appetite, griping pains, and watery stools long before sufficient mercury has been absorbed to favorably influence the course of the specific disease. Under these circumstances opium in small doses may be combined with it. This, I think, is undesirable, since the opium, though it may control the symptoms of stomach and bowel irritation, is not likely to lessen the catarrhal inflammation, the persistence of which materially interferes with proper absorption of mercury.

The yellow mercurous iodide (protiodide) may be given in pill or tablet form each to contain gr. $\frac{1}{6}$. The initial dose should be three pills daily, taken after meals. Every second day the dose is increased by one pill, till the earliest symptoms of salivation are produced. If, for instance, this occurs when twelve pills have been taken, after a period of rest devoted to curing the slight salivation, the pills are continued six a day, with intervals of rest, for four years, decreasing the dose and increasing the intervals of rest in the last two years.

Gray powder (hydrargyrum cum creta) may be found serviceable when yellow iodide disagrees, since it is not inclined to purge. It contains 38 per cent. of mercury, and should be given in 1-grain doses three to six times a day. Bichloride may be administered in doses of $\frac{1}{12}$ of a grain well diluted.

Because of the uncertainty of absorption when mercury is given by the stomach, and possibly because long continuance of the drug is likely to produce a condition of chronic gastro-enteritis, even though it be decided to treat syphilis by internal medication, it is well to supplement this, or rather to substitute it at regular intervals, by the more certain method of giving the drug by inunction. This substitution is particularly important if the disease is not running a favorable course—*i. e.* if there are frequent and severe relapses or the patient's general condition is rapidly deteriorating. A course of fourteen inunctions may be given every six weeks; after two years, every twelve weeks; after three years, every twenty-two weeks.

If it is impossible to employ inunction in this way, hypodermic

injections are serviceable. These also should be given in series and at intervals such as are appropriate for inunctions.

When, because of the amount of stomach irritation, one salt of mercury must be suspended, another may be substituted, remembering that one of the secrets of success in the use of the drug is to give it well diluted.

If after several attempts at substitution it is evident that mercury in any form by mouth administration is likely to keep up a chronic stomach indigestion and irritation of the bowels, the drug should be administered by inunction or by hypodermic injection.

Hypodermic Injection.—This method of administering mercury, so enthusiastically praised by certain leading syphilographers and heralded as the coming treatment of syphilis, seems now to have fairly found its place. It is not likely to supplant either inunction or mouth-treatment. It is, however, extremely serviceable in certain cases, and will probably be employed at times by nearly all syphilologists. Reference has already been made to the disadvantages of the method. It is often, not always, painful; it is impossible to predict when it will be painful or how long the pain will last: twenty injections may be given without occasioning any pain; the twenty-first given in precisely the same way may cripple the patient for days. It is more likely to produce severe toxic effects than when mercury is administered in any other form.

In careful hands abscess formation almost certainly can be avoided; therefore this need not be considered an objection to the employment of this method of treatment.

Two general classes of preparations are employed—the soluble and the insoluble. The soluble preparations are absorbed quickly, but their effect is transitory. The insoluble preparations lie in the tissues for months, acting as reservoirs from which is drawn a constant dosage of mercury. Their action is then slow, but prolonged.

Toxic effects much more frequently follow the use of the insoluble than of the soluble preparations. This can also be said of severe pain and suppurative inflammations.

As a rule, the soluble preparations are to be preferred for the reasons just given—*i. e.* promptness of action, painlessness, and comparative innocuousness. Probably the best preparation is that of corrosive chloride. The syringe employed should be clean; it is well to wash it out thoroughly with boiling hot water several times, after this using a mild solution of formalin or absolute alcohol. The needle should be sterilized by boiling in a test-tube immediately before its use. The skin should be scrubbed well with absolute alcohol, and the needle should be driven in vertically by a sudden thrust until its point enters the muscular tissue, since the injection, if thus made, is less likely

to give pain and cause suppuration, and is more quickly absorbed. It is true that suppuration beneath the deep fascia is much more dangerous and difficult to treat than that superficially placed; if the injection is properly practised, however, there is little danger of this accident. The beginning dose should not be greater than $\frac{1}{10}$ grain, unless it has been previously established that the patient is not especially sensitive to mercury. This dose can be steadily increased until $\frac{1}{3}$ grain three to six times a week is reached. In some cases I have given double or even triple this dose with benefit to the patient.

The injection may be driven into the dorsal region or into the buttocks. If the dorsal region be selected, the needle should be entered half an inch to the right or left of the first six spinous processes. This enables the mercury to be forced into the muscular tissues at points where they are not richly supplied by sensory nerves. The first injection should be placed to the right of the first dorsal spinous process; the second to the left; the third to the right of the second spinous process, and the injection should be so continued downward. In keeping a record of the case the seat of each injection can be readily marked down on a rough diagram. This is particularly important when insoluble preparations of mercury are used, since thus in case of serious mercuric intoxication the surgeon is enabled to cut directly upon the seat of injection and turn out the medicament which has not yet been absorbed. If the injection is driven into the buttock, the space between the tuber ischii and the crest of the ilium is selected, the seat of each injection being carefully recorded.

As to the number of injections and the length of time during which they should be continued, these are not so well formulated as is the case with inunctions or internal medication. The assertion, at one time vigorously held by a number of practitioners, that syphilis can be permanently and promptly cured by a few injections administered during the early secondary period, is clearly disproved. If reliance is placed upon the hypodermic method, it is safe to assume that mercury must be continued as long as by any other method of administration, and that the quantity of the drug absorbed must be as great. This necessarily implies a continuance of injections for several years, with intervals of rest, depending upon the form of the drug administered and the susceptibility of the patient.

As to the frequency with which injection should be repeated, the soluble preparation should be given every third day, with a rest of one week in three after the first year. The insoluble preparations, such as calomel and gray oil, should be administered once in seven days, with a rest of one month in three.

Of the soluble preparations, the one I have found most serviceable is the following:

℞. Hydrarg. chlor. corros., gr. v (0.3);
Sodii chlor., gr. iij (0.15);
Aquæ destillat., ℥j (30.0).—M.
Sig. A 1 per cent. solution of corrosive mercuric chloride; 10 to 30 minims (0.65–2.0) hypodermically.

A stronger solution than this was so frequently painful that it had to be abandoned. Even this comparatively weak solution will at times occasion so much suffering that patients refuse more than one injection. Some, however, take it for months, complaining little or not at all. The initial dose should be not greater than $\frac{1}{10}$ of a grain —10 drops. This may be increased by 2 drops each injection until the dose of 20 or 30 minims is reached. Beyond this it is not advisable to go, unless symptoms are unusually persistent and resistant.

Of the insoluble salts calomel, gray oil and yellow oxide are the preparations of choice. Calomel is administered in suspension, either in glycerin or in oily menstrua. It and all the insoluble preparations give more pain than the bichloride injections, and are more likely to cause abscess. The drug employed should have been recently sublimed by steam, and should be emulsified in either freshly boiled glycerin, olive oil, or vaseline. The preparation should be conducted under all antiseptic precautions, and the emulsion should be protected against contamination by a sterile cotton plug or rubber stopper. One grain of calomel, repeated once in five or seven days, is the average dose.

The injection mixture may be prepared according to the following formulæ:

℞. Hydrarg. chlor. mit., gr. j (0.05);
Glycerinæ purificat., ♏x (0.65);
Aquæ dest., ♏x (0.65).—M.
Sig. Use as an injection.

℞. Calomel, gr. j (0.05);
Vaseline, ♏xx (1.30).—M.
Mix well and use as an injection.

In place of vaseline, boiled olive oil may be employed.

Gray oil is an emulsion of metallic mercury, and is made by thoroughly mixing lanolin with chloroform, allowing the chloroform to evaporate by triturating, and adding mercury 2 parts to 1 part of the semifluid lanolin. One part of the resulting salve added to 3 parts of olive oil makes the ordinary gray oil. The object of this preparation is to secure minute division of the metal and to maintain complete fluidity; it is usually warmed before being used. From 1 to 2

minims are injected every four to seven days for a month, after which a rest of four to six weeks is given.

Yellow oxide is thus prepared for injection:

℞. Hydrarg. oxid. flav.,	gr. xv (1.0);
Acaciæ,	gr. iv (0.2);
Aquæ dest.,	fl℥j (30.0).—M.

Of this preparation 15 minims are injected at a time. Other insoluble salts of mercury which have been employed and warmly commended are the neutral salicylate in 1- to 1½-grain doses weekly, thymol acetate in 1½-grain doses at from three- to six-day intervals.

Of the insoluble preparations I prefer the following:

℞. Hydrarg. chlor. mit.,	ʒj (4.0);
Petrol. liquid. purificat.,	ʒj (4.0);
Lanolini,	ʒj (4.0).—M.

Sig. Three minims as an average dose.

The insoluble preparations usually require a hypodermic needle with a lumen larger than is necessary for the injection of absolutely fluid media. Nearly all combinations of mercury are likely to cause corrosion of the needle in a short time. This may be avoided by boiling the needle in slightly alkaline water immediately after it is used and washing it out with alcohol.

As to the value of the hypodermic method and the indications for its employment, there seems no reason for believing that it is likely to be adopted as a routine method of treatment in preference to other methods. The indications for its use are: In those cases in which, because of chronic gastro-enteritis or a particularly irritable stomach, all forms of mouth-ingestion are inadmissible and the employment of inunctions is impossible, either because of a sensitive skin or because of the environment of the patient; when from the seat of syphilitic lesion and its rapid advance the patient is threatened either by death or permanent crippling, and it is essential that the constitutional effects of treatment should be felt at the earliest possible moment; when the question of diagnosis must be settled promptly, as in the case of lesion of the tongue presenting some of the features of both gumma and cancer, or of sore upon the genitals not absolutely typical of chancre, and yet resisting local treatment—prompt disappearance of such a sore, together with the adenopathy under mercurial injections, would practically establish the diagnosis. The method is contraindicated when the kidneys are diseased and the patient is suffering from diabetes, marked visceral lesions of any kind, anæmia, or systemic dyscrasia.

The Use of the Iodides.—The value of the iodides in the treatment of syphilis is based on clinical experience. It is well known that these preparations powerfully stimulate the absorbent system; hence there is a partial explanation for their use in the lesions of late syphilis which are particularly characterized by excessive formation of imperfectly organized tissue made up for the most part of a small round-cell infiltrate. As a matter of fact, the iodides are of little service in primary or secondary syphilis, and it is not until the tertiary stage is reached—*i. e.* after eighteen to twenty-four months—that their use is indicated as a matter of routine practice. Exceptionally they may be efficient at a much earlier period.

Mauriac holds that iodides should be employed in the phagedenic forms of the initial lesion; in the beginning of the secondary period; especially to combat the headache and the erosive and ulcerative syphilides; in all the syphiloderms of transition, the papulo-squamous and papulo-tubercular; in all tubercular and all malignant syphilides; in all subdermic syphilitic manifestations; or in gummata or gummatous exudates that break down and ulcerate. He believes that the action of the iodides, though less rapid than that of mercury, is more certain and permanent.

Excepting in those early syphilides which approximate in type tertiary lesions—*i. e.* which are deep, ulcerative, and accompanied by extensive infiltration—the iodides are of such slight service in primary and secondary syphilis that their beneficial effects are more than counterbalanced by the irritation they produce upon the gastro-intestinal tract.

The dose of the iodides is to be measured by the effect produced upon the symptoms. This may lead to the administration of an ounce or even more of the drug daily; usually much smaller doses are efficient.

As to the administration of the drug, it is a point of cardinal importance that it should be given well diluted. At about the eighteenth or twenty-fourth month of syphilis it is the habit of the majority of syphilographers to continue the mercurial treatment, adding to it potassium iodide; this even in the absence of symptoms. Such a practice was perhaps originally based upon the theory that the usefulness of the drug was dependent upon the influence it exerted in rendering soluble and potent the residuum of a prolonged mercurial course and in encouraging its elimination. As far as elimination of mercury is concerned, modern research has failed to corroborate this belief. The reason for the administration of an iodide nevertheless exists, since it is a powerful absorbent, not only causing fatty degeneration and disappearance of huge gummata, but preventing the development of infiltrates.

For what is called the mixed treatment—*i. e.* the administration of mercury and potassium iodide—the formulæ vary in accordance with the method by which the mercury has been given. When the latter drug has been administered either by inunction or hypodermic medication, the iodide may be given in saturated solution, as will be presently described. If the mercury has been administered by the mouth, the following formula will be found serviceable:

℞. Hydrarg. iodidi rubri, gr. iv (0.2);
Potassii iodidi, ℥ss (15.0);
Syr. sarsap. comp., ℥vj (180.0).—M.
Sig. Teaspoonful in half a glass of water three or four times daily.

The quantity of the iodide and of the mercury may be varied to suit the requirements of the case. In the absence of symptoms 15 to 20 grains of iodide a day is as much as need be taken.

As a rule, it is better to give the iodides and mercury separately. For this purpose a saturated solution of iodide of potassium should be ordered, as follows:

℞. Potassii iodidi, ℥v (20.0);
Aquæ, q. s. ad f℥j (30.0).—M.
Sig. Five drops thrice daily in a glass of milk or water, increasing as required.

When advancing tertiary lesions so placed as to jeopardize life and usefulness are present, the dose should be rapidly increased. Thus the initial dose of 5 grains daily may be given to determine whether or not the patient exhibits an idiosyncrasy toward the drug. This dose should be doubled the following day, and thereafter should be increased 10 grains a day, remembering that the cardinal point in toleration, in at least so far as the stomach and intestines are concerned, lies in abundant dilution.

When the drug disagrees, and particularly when it has to be given in colossal doses, it is very well to combine it with essence of pepsin in the proportion of 10 grains to a teaspoonful, or, still better, to put the required number of drops of iodide in a glass of milk, adding essence of pepsin and a little sherry wine or other flavoring matter; the patient then takes the junket, which forms in a few minutes. Thus given, the stomach is extremely tolerant to the drug. At times other combinations of iodine are less irritating and more efficient than the potassium salt. A serviceable formula is the following:

℞. Potassii iodidi,
Sodii iodidi,
Ammonii iodidi, āā. ʒij (8.0);
Syrup. aurantii cort., fʒj (30.0);
Aquæ, q. s. ad fʒvj (180.0).—M.

The rubidium iodide has been warmly commended by Neumann. In the limited trial I have given it it has proven even more irritating than the potassium iodide. Iron iodide is serviceable when anæmia is marked.

It must be remembered that in the case of the iodides the production of slight toxic symptoms does not indicate that the full physiological effects of the drug have been obtained, and that when serious damage is threatened by a specific lesion the drug should not be stopped the moment coryza or other slight toxic effects become manifest. For diagnostic purposes it is often necessary to administer very large doses. Under these there seems good reason for believing that exceptionally infiltrations due to causes other than syphilis will disappear. If, however, distinct lesions are cured by mercury and iodides, this, practically, is sufficient ground for a diagnosis of syphilis.

The indications for the use of iodides are—

1. After two years of treatment with mercury, and in combination with this drug, in doses of 15 to 20 grains a day, provided there are no syphilitic symptoms. Iodides should be continued under these circumstances for six months.

2. In precocious secondary syphilis—*i. e.* when lesions are tertiary in type, affecting fibrous or connective tissues, bones, nerve-cells, or viscera, or when they cause deep ulceration or marked infiltration of the surface.

3. In all forms of tertiary syphilis.

Baths in the Treatment of Syphilis.—Baths are employed either for the purpose of causing absorption of mercury, the drug being held in solution in the bath, or for increasing metabolism and hastening elimination, thus allowing much larger doses of the medicament to be ingested than could otherwise be taken.

Mercurial baths are, under exceptional circumstances, extremely serviceable—thus when the skin-lesions are widespread and of a pustular or ulcerating type, or when, because of easily disordered stomachs and hypersensitive skins, patients do not readily tolerate either internal medication or inunctions.

A partial bath is often employed advantageously when lesions develop in particular regions, as about the buttocks or genitalia or upon the hands and feet.

The strength of the corrosive chloride bath should be 1 in 20,000;

the water should be at a temperature of between 80° and 90° F.; the bath should be continued for between one and two hours, the temperature being maintained at a proper degree by the addition of hot water as it is required.

Hot-air, -water, or steam-baths given for the purpose of stimulating metabolism are steadily growing in favor. I have been in the habit of ordering hot baths in the routine treatment of syphilis whenever the patient exhibits no idiosyncrasy against them, and when his circumstances are such that they can be taken. It is highly probable that all the advantages of the thermal springs, excepting those incident to change of air and surroundings, can be obtained by the judicious use of hot baths at home. It is absolutely certain that by their use much larger doses of mercury can be tolerated, and that, as a rule, the general health is markedly improved. The Turkish bath taken daily or three times a week is the most serviceable form of applying heat and moisture. Next in order of efficiency comes the hot-air bath, and, finally, prolonged hot soaking in water (from 108° F.).

Arrangements may be made for the daily hot steam-bath in almost any bathroom or bedroom. At a very moderate expense an apparatus can be purchased, or a box can be constructed of such height and size that a patient sitting on a chair has his body entirely enclosed, with his head thrust through a hole in the top. In this box beneath or behind the chair is placed a gas stove or coal-oil or alcohol lamp. The patient is seated in the box, the lamp is lighted, the door and lid are closed, towels are packed about the opening through which the head projects. In five to fifteen minutes a dripping perspiration is produced. The patient then takes a cool shower-, sponge- or plunge-bath and dries himself vigorously with a towel. This bath should be taken every morning unless from idiosyncrasy it is found to be weakening. It is usually refreshing, and under it patients gain in weight. Even when these hot vapor-baths are taken, I believe one or two Turkish baths in a week are serviceable.

Borovski, who has made a careful study of the effect of hot baths in the treatment of syphilis, shows that both tepid and hot-water baths as well as those of sulphur and hot air, invariably increase the elimination of mercury in the urine, and that this elimination proceeds more energetically the higher the temperature to which the patient is exposed. He holds that the organism of the patient who has been mercurialized can be entirely freed of the drug by means of the systematic employment of heat, and that mercurial stomatitis can be cured by this agency more quickly than by any other means. Hot-air baths are especially serviceable, since the drug is eliminated through the sweat-glands, which are so powerfully excited. These are especially

to be preferred when it is desirable to clear the patient's system of the drug. The precaution should always be taken when hot baths are given to have an attendant present, since syncope is sometimes produced. In themselves hot baths are powerless to cure syphilis.

Aside from the more careful use of the specific drugs, the avoidance of mercurial intoxication, closer attention to the general condition of the patient, and the treatment of dyscrasia with which the disease may be associated, the therapeutics of syphilis has not been materially changed in recent years. But two suggestions worthy of note have been advanced: one is a different method of administering mercury; the other is the application of a new therapeutic principle to syphilis.

Intravenous Injection.—Bacelli has proposed to give mercury by *intravenous injection of corrosive chloride*, holding that thus the dosage is more accurate and the effect more rapid and powerful than when a much larger amount of the drug is given in other ways. This is the solution he employs:

℞. Hydrarg. chlor. corros., gr. j (0.05);
Sodii chlor., gr. iij (0.15);
Aquæ dest., ʒij (60.0).—M.
Sig. From 20 minins to a drachm daily by intravenous injection.

The median basilic or cephalic vein is made prominent by winding a fillet about the arm and getting the patient to contract the muscles strongly with the elbow extended. The skin overlying the vein is thoroughly cleansed, and the needle of the syringe, after having been boiled and attached to the filled syringe, is driven directly into the vein. The injection is then made slowly. If it is not painful, and particularly if there is no subcutaneous tumefaction, it has evidently passed into the lumen of the vein and been carried away by the blood.

Intravenous treatment of syphilis has not been tried in a sufficient number of cases to determine its value or its harmlessness. It should be considered as a means of bringing the system rapidly under the influence of mercury when progressive lesions threaten vital organs.

The serum treatment of syphilitic lesions dispenses altogether with mercury and iodide of potassium, and attempts to combat syphilis by injecting into the system an antitoxin which inhibits or destroys the germs of the disease. The commonly accepted theory in regard to immunity from any disease rests on the fact that as a result of the introduction of micro-organisms into the system there are produced substances not only injurious to the host, but also those which either destroy the micro-organisms themselves or render the soil in which they grow immune against infection. The clinical history of syphilis

leads us to believe that this immunizing substance is found in the blood of man, and that upon its existence depends, for instance, the resistance which the apparently sound mother of a syphilitic child offers against contracting the disease either from her offspring or from any other source, or the resistance which the apparently sound child of syphilitic parents offers against contracting the disease. It is believed that the protecting serum is filtered through the placenta, and that immunity from maternal syphilis would be observed very much more frequently than is now the case, were it not that through traumatism or inflammation the indirect communication between the maternal and fœtal blood is made direct, and hence not only the immunizing substance, but the active living micro-organisms, are carried from the diseased to the healthy human being, and thus in place of acquiring simple immunity the child has implanted upon it syphilis itself.

It is apparent, since the kidneys are functionless in intra-uterine life, and since the micro-organisms of syphilis exhibit especial virulence when they attack the fœtus, that there should be in the circulation of the child syphilitic at birth both immunizing substances and toxic products in unusual concentration. These may be separated from each other by heat.

On the basis of these considerations Bonaduce conducted a clinical study with blood-serum from children hereditarily syphilitic. The results in a few cases were apparently extremely favorable. Various modifications of the serum treatment have been reported with apparently satisfactory results. It is still, however, absolutely in its experimental stage.

Local Treatment of Syphilis.

The chancre should be kept clean and protected from irritation. It must be remembered that it offers an open granulating surface, hence that infection with the ordinary pyogenic germs may readily take place and involve the lymphatics. Indeed, suppurating bubo from chancre is more common than is generally supposed.

I have already advised that chancres should be removed as soon as they are seen, and that the resulting wound should be closed by suture. This is the best treatment, and, even though it does not abort syphilis, it is followed by prompt healing. Under internal medication healing is, however, very rapid.

When the surgeon believes in allowing the chancre to reach its full development, the germs to become widely diffused through the system, unchecked by specific treatment, and eruptions to develop upon the skin and mucous membrane before the administration of mercury, the chancre may become large and troublesome. Under

these circumstances it should be cleansed night and morning, preferably by spraying it with dilute antiseptic solution, carbolic 1 : 500, bichloride to 1 : 5000, dried, and dusted with calomel and zinc oxide, equal parts of each. If this exhibits a tendency to crust, with retention of discharge beneath and congestion and œdema about the sore, wet dressings or ointments are indicated. Wet dressings are best applied by soaking pledgets of cotton in black-wash, placing them over the sore, and securing them in place by a gauze bandage kept constantly wet with a solution of lead-water and alcohol, equal parts.

A serviceable ointment when the discharge, though moderate, is too free to allow the use of a dusting powder, is—

℞. Ichthyol, ʒss (2.0);
Emplast. hydrarg., ʒiiiss (14.0);
Cerat. resinæ, ʒiv (16.0).—M.
Sig. Locally.

Sluggish granulation should be touched with the solid stick of silver. A tightly adherent pseudo-membrane should be destroyed by nitric acid or acid nitrate of mercury, or should be scraped off with a sharp curette, the part being subsequently cleansed and dressed as already described.

Chancres in which the discharge is extremely slight or those in which there is no ulceration are best protected by a film of cotton kept in place by collodion.

Syphilitic buboes—*i. e.* the enlargement of the lymphatic glands anatomically related to the seat of chancre—are best treated by inunctions of mercurial ointment, a quarter of a drachm being rubbed in daily over each bunch of glands.

The syphilides are benefited by the application of mercury to the surface and the systematic employment of hot baths.

The erythemata respond so promptly to medication that they rarely require local treatment.

Papular syphilides are often obstinate, particularly when they appear in the papulo-squamous form. They yield best to inunction and massage and vapor-baths. Local vaporization is especially serviceable. Thus, when the hand is affected it may be placed in an inverted box which is filled with calomel vapor by means of an alcohol lamp and a small metal dish.

Mucous patches are best avoided by cleanliness; when they appear they may be brushed several times daily with the solid stick of silver nitrate or a 10 per cent. solution of this drug. An antiseptic astringent mouth-wash should be used frequently, together with a mild antiseptic spray. As a mouth-wash diluted tincture of myrrh answers

excellently, a teaspoonful of the myrrh being added to a glass of water. It must be remembered that the appearance of mucous patches usually indicates that mercury is not being absorbed in sufficient dose to control the disease; hence in addition to the local treatment it is wise to push the specific treatment for the time being.

Ulcerative patches in the fauces should be subject to the same treatment as mucous patches.

Scaly patches on the mucous membrane are exceedingly obstinate to treatment, and may persist for weeks or months, nor do they seem to be beneficially affected by pushing general treatment. They sometimes disappear under the stimulant and resolvent effect of iodine, which may be used locally as in the following prescription:

℞. Iodi,	ʒij (8.0);
Potassii iodidi,	ʒiij (12.0);
Glycerinæ,	ʒiij (12.0).—M.
Sig. Apply locally to scaly patches.	

A cauterant effect is usually required, such as that resulting from the application of a 10 per cent. chromic-acid solution or acid mercuric nitrate, one-half strength. The sharp curette is sometimes needed for their removal.

Condylomata may be destroyed by applying to them

℞. Plumbi oxidi,	gr. iv (0.2);
Liquor potassii caust., 33 per cent.,	ʒij (8.0).—M.

Iodoform is then dusted over the surface. In two or three days the crust thus formed comes away. The application may have to be repeated two or three times. Chromic or nitric acid is a more certain cauterant. In mild cases no local treatment is required beyond cleaning and dusting with calomel. Very extensive cases should be shaved off with a knife.

The pustulo- or pustulo-crustaceous syphilides are favorably affected by mercury or vapor baths, supplemented by calomel and zinc ointment.

Tubercular and non-ulcerating gummatous syphilides are best treated locally by the continuous application of mercurial ointment. Absorption seems to be encouraged by the hot-water bag, which may be placed directly upon the dressing which contains the ointment.

Exceptionally, there develops a chronic serpiginous, slowly-spreading, persistent syphilide, which seems to resist all forms of local and general treatment. This lesion may yield to a prolonged bath lasting days or weeks. If this fails, the actual cautery should be tried.

Ulcerating surfaces are treated by the curette and the cautery in

accordance with general surgical principles, and diseased bone is subject to the same surgical treatment as when due to causes other than syphilis.

Hereditary Syphilis.—As in the acquired disease, hereditary syphilis is treated and cured by mercury and potassium iodide. By appropriate treatment directed to the parents, transmission of the disease may often be prevented, though the only sure prophylaxis, and one which the practitioner should invariably advise, is the avoidance of marriage, or certainly the avoidance of paternity, for a period of at least four years after the appearance of a chancre. When patients who are syphilitic marry they should be subject to the most careful and persistent treatment.

If pregnancy should occur from a syphilitic father, the mother should receive constitutional treatment during the entire period of utero-gestation. This is even more imperatively indicated if she has been previously syphilitic or has been infected at the time of conception or shortly before or after this.

Immediately after birth the syphilitic child should be given a mercurial, and specific treatment should be continued with appropriate intervals of rest for at least four years. It would seem wise to lengthen the period even beyond this, giving such children an intermittent course of treatment until past the age of puberty.

The children of syphilitic parents may exhibit lesions of syphilis at birth, may be healthy at birth but in from three to five weeks may develop characteristic symptoms, or may be healthy at birth and remain without any manifestations of syphilis throughout life. To a child exhibiting lesions at birth specific treatment should be given at once. If the child is apparently healthy at birth, it should also be treated at once if the syphilis is maternal and recent and has not received vigorous mercuric treatment. If, however, the syphilis is old, is paternal, and has been vigorously treated, and if, moreover, during the period of utero-gestation the mother has received properly directed specific medication, it is safe to wait for the manifestations of syphilis before treating the child.

In cases not corresponding to either of the types just mentioned it is probably wise to wait for secondary symptoms, in the mean time making a careful examination of the child's blood, and instituting treatment the moment this shows diminution in hæmoglobin and increase of white corpuscles without appreciable cause other than syphilis.

The method of treating a child is as follows: The surface of the belly is washed with castile soap and warm water, then with a saturated solution of boric acid, and is finally dried. Upon the child's binder is spread half a drachm of an ointment made up as follows:

℞. Acid. carbolic., ♏j (0.05);
Ung. hydrarg., ʒij (8.0);
Cosmoline, ℥j (30.0).—M.

The binder is then applied as is usual in infants, and is worn for twenty-four hours, after which the belly is again washed with soap and water, followed with boric acid; ½ drachm of the ointment is rubbed in and the binder again applied. This binder is changed for a fresh one every fourth day.

Should dermatitis result from the prolonged application of the ointment, the inflamed skin should be washed with witch-hazel, dusted with carbolized talc, and the mercury should be administered in the form of inunctions, various surfaces being selected for the rubbings, the dorsal region being the one of choice.

It happens at times that because of the hypersensitive skin inunctions cannot be given. Under such circumstances it is wise to resort to hypodermic medication, a solution of 1 per cent. sublimate being used. The initial dose should be 1 minim, $\frac{1}{100}$ grain, every second day, the quantity being gradually increased to 2, 3, or 4 minims.

If the sublimate injections cannot be administered, medication by the mouth is indicated. Probably the most efficient formula is the following:

℞. Hydrarg. cum cret., gr. iii–iv (0.15–0.2);
Sacchar. albi, gr. iv (0.2).—M.
Div. in chart. No. xij.

One powder three times a day, to be taken soon after nursing.

The mercurial should be continued alone with intermissions for two years, after which, for a period of six months, potassium iodide should be added. The formula suggested by Bumstead and Taylor is—

℞. Hydrarg. iodidi rubri, gr. j (0.05);
Potassii iodidi, ʒiv (16.0);
Syr. sarsaparillæ comp.,
Aquæ, āā. f ℥ij (60.0).—M.

Of this mixture a patient over five years old may take half a teaspoonful, the dose being gradually increased to 1½ teaspoonfuls three times a day. For younger children the dose is proportionately diminished. At the time this is being given the mercurial ointment is used externally.

It is probably better to give the iodides separately, a saturated solution being employed, and the drops being administered in milk, which so disguises the taste of the drug that it is taken without dif-

ficulty. The initial dose for a child two years old should be 1 grain three times daily. This may be increased a grain at a time.

It is often wise to employ the iodides considerably before the end of the second year, since hereditary syphilis exhibits a tendency to become tertiary in type even in the early secondary period. Under such circumstances the iodides should be added to mercurial treatment.

In very exceptional cases where inunctions, hypodermic medication, or mouth-administration are impracticable, mercury may be given to the mother with the idea of influencing the child through her milk. This is at best, however, an uncertain and unsatisfactory method of treatment.

The periods of rest in the systematic treatment of a syphilitic child correspond in general with those already described as appropriate in the treatment of syphilis in the adult. The reason for continuing the treatment somewhat longer is founded upon the much greater virulence of hereditary syphilis, and the strong tendency which the disease exhibits to recur at the periods of dentition and before and during puberty.

Parasyphilitic Phenomena.—Though it has been many times repeated that mercury and iodide of potassium will cure syphilis, this must by no means be taken to mean that every person who has suffered from syphilis should be given these drugs for the cure of all maladies from which he may subsequently suffer.

Following syphilis, often by a long interval, are many phenomena which Fournier has aptly termed parasyphilitic. These may be in part due to the destructive effect of the original disease, but are not syphilitic in any other sense, and are not modified in the slightest degree by syphilitic treatment. Thus, herpes is extremely common in those who have had syphilis. Mercury distinctly aggravates it; it is not influenced favorably by any form of treatment.

Headaches are not uncommon in the late tertiary period of syphilis. Often, probably in the majority of cases, they are of inestimable value, being prodromal of grave brain lesions, and leading the practitioner to institute early an active course of treatment which, if sufficiently vigorous and prolonged, will prevent the development of incurable brain lesions. There is, however, another form of headache the prognosis of which, in so far as paralysis or other grave brain lesions are concerned, is not alarming, but which persists for months or years and is aggravated by specific treatment. It corresponds to the neurasthenic type of cephalalgia, and is benefited by the treatment adapted to neurasthenia.

In determining between these two forms of headaches it should be remembered that syphilitic cephalalgia prodromal of brain lesions never lasts more than a few weeks or months before the unmistakable

symptoms of profound brain involvement develop, and that the beneficial effects of vigorous treatment are noted promptly.

In hospital practice, and exceptionally among private patients, the surgeon occasionally sees syphilis manifested in the form of profound cachexia, marked involvement of the liver, spleen, and kidneys, and extensive destruction of the bones and overlying soft parts. Specific treatment avails little in these cases.

Perhaps the safest rule to follow in the late lesions, whether they be of the surface, the viscera, or the nervous, vascular, or respiratory system, is to make one faithful effort with mercury and the iodides. If no improvement is noted, or if, as is often the case, symptoms are aggravated, reliance should be placed upon general tonic and supporting treatment. The trial with the specifics should, however, be thorough and should be conducted under the most favorable circumstances.

In conducting the treatment of syphilis there are rules of procedure to be observed and cardinal facts to be remembered so important that I cannot do better than close my paper by formulating them as follows:

Summary of the Treatment of Syphilis.

1. The constitutional treatment of syphilis should be inaugurated as soon as a probable diagnosis of chancre has been formulated.

2. The first step in the treatment should be the excision of the chancre.

3. Mercury should be the basis of treatment in all periods of syphilis.

4. This is most efficient when administered by inunction.

5. The proper dose of mercury is the largest which can be taken without injury to the health. The development of lesions indicates that an insufficient dose of mercury is being absorbed. When during the course of specific treatment there is steady deterioration in the health, the physician must assure himself that this is not due to mercurialization.

6. A daily hot-air bath enables the patients to take larger doses of mercury than is possible without this form of bathing.

7. Treatment should be continued for at least four years, with appropriate intervals of rest. After the second year a six months' course of iodide of potassium should be added to the mercury.

8. Tertiary symptoms are best treated by a combination of mercury with the iodides.

9. When late tertiaries develop after a four-year course, treatment should not be limited to the cure of such tertiaries, but should be continued for at least six months afterward, and should be vigorous. This is particularly important in cerebral syphilis.

10. Parasyphilitic phenomena should not be treated by mercury and the iodides.

11. Patients with syphilis should not be allowed to marry until four years have elapsed from the development of the chancre. Syphilis may be transmitted much later than this, but only as a rare exception.

12. A child of syphilitic parents is best protected from inheritance of the disease by vigorous mercurial treatment of the mother during the period of gestation. This treatment must be strictly confined within the toxic limits.

13. Treatment of syphilitic children should continue with intermissions beyond the period of puberty.

THE TREATMENT OF TUBERCULOSIS.

By LAWRENCE F. FLICK, M. D.

It may be laid down as a general proposition that disease is curable in proportion to the amount of disease-producing matter which has entered an organism and the length of time during which the organism has struggled to rid itself of it. There is an inherent power in every living organism of purging itself of disease-producing matter, and there is a natural tendency in disease-producing matter to subvert the regular order of things in the organism and to weaken its machinery. Disease is a conflict in an organism between forces which seek to maintain the integrity of the organism on the one hand, and forces which seek to destroy that integrity on the other. The advantage in the conflict is with the organism, because the innate powers of self-defence grow with exercise, whilst the invading force has to maintain itself in the enemy's country, so to speak, and is liable to be starved out by exhaustion of the soil upon which it feeds. Nevertheless, victory is often with disease, and this is so mainly because secondary forces which are the product of civilization and of sin enter the struggle on the side of disease. What is true of disease in general in this regard is true of tuberculosis in every detail, and is perhaps better exemplified in tuberculosis than in any other disease. The importance of this truth cannot be too much emphasized in a study of the treatment of tuberculosis, because it is usually overlooked, and because the principle involved gives the keynote to correct treatment. Without an ever-abiding faith in the curability of tuberculosis and a full appreciation of the natural forces which work on the side of cure, together with a thorough knowledge and understanding of the relative diminution of the forces in direct ratio with the progress and duration of the disease, the physician, who seeks to cure it, is seriously handicapped.

In olden times the disease which we now call tuberculosis was called tabes, phthisis, and consumption, and was recognized as one and the same disease throughout its entire course; but it is probable that it frequently went unrecognized in its earlier stages, and that in the more acute forms it often was mistaken for some other disease. With the study of pathology the name tuberculosis became asso-

ciated with the disease; and then, too, the belief sprang up that the disease, which had formerly been looked upon as one, was really two diseases—one of a very acute character, with disseminating tubercles as the distinguishing feature, and this was called tuberculosis; and the other of a very chronic character, with wasting as the distinguishing feature, and for this the old names of phthisis and consumption were retained. Later on—indeed, in comparatively recent times, when it became known that in every case of consumption there has been a time when there were tubercles, and that tubercles are an essential factor in consumption—the name of tuberculosis began to be applied also to those conditions which before had been designated phthisis and consumption, and the clinical phenomena which had been looked upon as expressive of two diseases were again interpreted as representing but one disease in different stages and under different conditions. In this advanced position there is a disposition to abandon the words phthisis and consumption in scientific nomenclature, and to designate every case of disease, in which the tubercle bacillus has been the initiative cause, tuberculosis. It seems, however, that the pendulum has swung too far, and that it must again swing back before the correct scientific position in this matter has been attained. The latest word spoken from the laboratory, although it does not corroborate the correctness of the earlier position about duality of disease, nevertheless justifies the retention in medical nomenclature of the word consumption along with that of tuberculosis. It is pretty clearly established now that when the tubercle bacillus colonizes in the human organism it gives rise to clinical phenomena which are distinctive enough in character to be recognized, and that the individuality of the clinical picture is maintained no difference what part of the body may have been invaded. It has also been pretty clearly proved that the clinical phenomena which in early times found expression in the word consumption are not due to the colonization of the tubercle bacillus, and that they are due to other disease-germs which fraternize with the tubercle bacillus, but may also fraternize with other pathogenic organisms. These are pus-producing organisms, such as the streptococci and staphylococci. The clinical phenomena set up by these pus-producing germs are likewise distinctive enough to be easily recognized, and are always the same, no difference whether they have invaded the system primarily or secondarily, or whether they are secondary to the tubercle bacillus or to some other pathogenic organism.

In the interest of lucidity and for a better understanding of the treatment of tuberculosis, it would be well to retain both nomenclatures, and to let each describe that condition which it actually represents—namely, tuberculosis for that condition in which the

tubercle bacillus alone is colonizing or has colonized, and consumption for that condition in which the tubercle bacillus is supported in its devastations by the pus-producing germs. It is the more important to outline clearly the two conditions and to keep them apart because both the prognosis and the treatment of them are radically different. In tuberculosis pure and simple from 75 to 80 per cent. of the cases are curable under proper treatment; in consumption from 75 to 80 per cent. will prove fatal under any treatment that may be instituted: between the two there are many shades of cases which are curable or incurable in proportion as they lean more to the one or the other class. In the treatment of uncomplicated tuberculosis we have a very simple task before us; in the treatment of consumption we have an exceedingly difficult one. We can best grasp the idea of each when we study them separately.

There are other complications of tuberculosis besides that set up by the pus-producing germs which must be briefly considered, preliminary to a study of the treatment of the disease. The pathogenic organisms which give rise to the different kinds of colds, and the germ which produces influenza, all fraternize with the tubercle bacillus both when alone and when it has joined hands with the pus-producing organisms. The pneumococcus likewise will invade the human body when the tubercle bacillus is a guest; but it is doubtful whether the two will work in harmony. They may indeed be antagonistic to each other. These various complications bring to tuberculosis distinct features, which require special treatment; and in the interest of clearness each will be considered by itself in the proper place.

The treatment of tuberculosis may be divided first into two grand divisions, namely (1) the preventive and (2) the curative. These major divisions each again may be divided into minor divisions: preventive treatment into (*a*) public prophylaxis and public hygiene, (*b*) private prophylaxis and private hygiene, (*c*) treatment of predisposition; curative treatment into (*a*) climatic treatment, (*b*) dietetic treatment, (*c*) dynamic treatment, (*d*) medicative treatment.

PREVENTIVE TREATMENT.

The saving of human life and suffering is the greatest natural privilege with which God has entrusted man. It is a divine prerogative for his ennoblement, through the agency of scientific medicine, and constitutes the measure by which the physician must determine his shortcomings and successes. To it the profession owes its honorable position in the world; and in it the army of earnest devotees to

medical science finds its inspiration. What a contrast between this army and that other army of human beings whose object is the destruction of life! Already the world is an insolvent debtor to medicine for what has been accomplished in the prevention of disease. The angel of death can no longer mow his wide swath at will—the plagues of Egypt are halted at the confines of civilization. Not only have many of the most malignant acute diseases been stamped out of civilized life, but even so insinuating and chronic a disease as leprosy stands checked at the borders of civilization. In leprosy, tuberculosis has a foreshadowing analogue. The honor which came to the medical profession in the fifteenth and sixteenth centuries through the extinction of leprosy is destined for the profession in the twentieth century through the extinction of tuberculosis. The result will be accomplished in much the same way, but more humanely, and probably more speedily.

Public Prophylaxis.—In all civilized communities it is the function of the government to safeguard the subject in his life and physical well-being. This is specifically stipulated in the fundamental laws of both the United States and Great Britain. There can be no quibbling, therefore, in these countries at least, about the duty of the government to the people in regard to tuberculosis. Science has proved that tuberculosis is a preventable disease, and has pointed out the way in which the disease can be prevented; the duty of the government follows as an irrefutable sequent. The exercise of this duty involves new departures in governmental administration and the outlay of large sums of money; but the government may not consistently shrink from these. It spends millions of dollars, sacrifices many valuable lives, and cuts loose from ancient precedents for the defence of commercial interests, national honor, and sentiment, and this, too, when there is an alternative in arbitration, by which life and treasure could be spared; how much better reason for spending money to save hundreds of thousands of lives and prevent unspeakable suffering and anguish, especially when there is no other way of accomplishing it. The indifference and inactivity of the government in this matter are inexplicable except upon the ground of ignorance and inappreciation of what can be done and what the doing of it would mean; and hence the first duty of the medical profession is to educate the public upon the subject so that practical fruit in the form of appropriate legislation may be borne in the legislatures and municipal councils.

Public prophylaxis will have to assume the form of legislative enactments and sanatory administration. Although the principle of prevention of disease is well woven into the fabric of our fundamental laws, we are woefully deficient both in specific legislation,

embodying the principle, and administrative machinery for carrying it into practice. For the prevention of tuberculosis almost nothing as yet has been done in the United States, either in legislation or administration. The whole scheme remains to be developed; and the probabilities are that it will have to be developed piecemeal by boards of health, since none of our governments have yet budded forth departments of health. A comprehensive scheme for the prevention of tuberculosis will imply:

First. Registration of all cases of tuberculosis in man and in domestic animals.

Second. Practical instruction and aid in individual prophylaxis to every tubercular subject who needs such instruction and aid.

Third. Sterilization of houses and fomites which have been contaminated by tubercular subjects.

Fourth. Establishment and maintenance of hospitals and sanatoriums for the treatment of the tubercular poor.

Fifth. Exclusion of tubercular subjects from occupations in which they can contaminate food, clothing, and implements.

Sixth. Pensioning of tubercular subjects deprived of occupation and of those dependent upon them for support.

Seventh. Regulation of emigration and migration of tubercular subjects.

Eighth. Regulation of sale or gift of articles which have been used or handled by tubercular subjects.

Ninth. Extermination of tuberculosis among dairy cattle and domestic animals.

Tenth. Inspection and regulation of dairies and slaughter-houses.

Eleventh. Restriction and regulation of the spitting-habit.

Such a scheme as this cannot be put into operation in its entirety until we have an harmonious system of health departments engrafted upon our federal, state, and city governments. But, under our present régimé of boards of health, some of the measures enumerated can be inaugurated, as indeed some have been. In every borough, town, and city in which there is a health officer or board of health, registration of tubercular subjects, practical aid and instruction in individual prophylaxis to tubercular subjects, and sterilization of contaminated houses and fomites can be instituted under the powers which such health officers and boards already possess. No new legislation is required for such purposes. Inspection and regulation of dairies and slaughter-houses can also be practised and, in some States, in which legislation has been enacted upon the subject of tuberculosis among dairy cattle, a warfare upon tuberculosis in dairy cattle can be inaugurated. For the establishment and maintenance of hospitals and sanatoriums; for the exclusion of tubercular subjects from

occupations in which they can contaminate food, clothing, and implements; for the pensioning of tubercular subjects deprived of occupation and of those dependent upon them; for the regulation of emigration and migration of tubercular subjects; and for the regulation of the sale or gift of contaminated articles, new legislation will be needed in almost every State in the Union, and in all probability also by the United States.

In behalf of registration, there is this to be said, (1) that it is essentially the first step in an orderly scheme for the prevention of tuberculosis, and (2) that it is prerequisite for the extension of instruction and aid to ignorant and needy tubercular subjects, and for sterilization of houses and fomites. The majority of tubercular subjects are poor, and many are too poor even to employ a physician. A great many are ignorant, and some who have been intelligent are mentally inhibited and repressed by the disease. Such poor unfortunate people often have to earn their own livings, and sometimes have to earn livings for dependent, helpless relatives, such as cripples, infants, and the aged. They are always half-starved; they are suffering from the ravages of a merciless disease—shivering, burning, sweating, aching, and fainting, day in and day out, always in the harness, doing their day's work in a mechanical way because they are spurred on by stern necessity; they often work all day and cough all night; and as they do not eat well, but subsist largely upon stored-up tissue, their brains are neither nourished by food nor refreshed by sleep: how can they concern themselves about preventive measures and grasp the meaning of such measures? What such poor people need is a kind, sympathetic, helping hand; and such cannot be extended until it is known who and where they are. The method by which registration is to be accomplished will have to be determined by the health officers of each locality. The most available agencies at hand are physicians and poor-directors. For services of this kind required of a physician a small fee should be paid.

Practical instruction and aid in individual prophylaxis should be given by the health officers to every tubercular subject who may need them. Well-to-do patients are able to take care of themselves, but should be supplied by the health officer with information about what to do. The attending physician cannot be depended upon always for supplying this information; sometimes because he is too busy, and again because he lacks confidence in himself in such matters or because he takes no stock in such new-fangled ideas. A plain, explicit circular, in which are set forth the contagious nature of the disease, the methods by which the patient can make himself harmless to others, and what others should do to avoid contracting the disease, ought to be sent to every tubercular subject. With the poor, this circular

should be followed by a visit from a health officer to explain fully what is meant by the circular and to supply what may be needed for carrying out the instructions given.

Sterilization of houses and fomites after contamination with tuberculosis should be most thorough, and must be accomplished in a different way from the ordinary methods of sterilization. The contagion of all contagious diseases is preserved in houses and fomites by being cachéd in necrosed tissue, and this necrosed tissue varies very much in grossness and density in different diseases. In tuberculosis the particles containing and protecting the disease-germs may be quite large and impenetrable to gases. Sterilization cannot be accomplished, therefore, by fumigation with sulphur, and it is doubtful whether it can be satisfactorily accomplished with formalin gas. The only method that can give absolute safety is removal of every particle of necrosed tissue. In a house or room this can best be brought about by washing down and scraping the walls, and repapering them if they have been papered, by washing the walls with soap or a germicide when they have been painted, by scrubbing all the woodwork and floors with soap and water, and by washing the furniture with soap and water or a germicide. Carpets and upholstered furniture which cannot be washed should be either steamed and renovated or subjected to a high dry temperature. If this cannot be done, they should be whisked with a strong solution of corrosive sublimate or carbolic acid. Bed-clothing and washable goods should be thoroughly boiled and washed. The clothing which the patient has worn should either be destroyed by burning or thoroughly sterilized. For sterilization they should be boiled, subjected to a high dry temperature, or thoroughly cleansed with a strong solution of corrosive sublimate or carbolic acid. If the patient has been of cleanly habits, the bedroom only needs to be sterilized; if not, the entire house requires it. But even when the patient has been cleanly in his habits it would be well to have all carpet in the house renovated and to have the house thoroughly cleaned from top to bottom. Everything which has been used by the patient should be carefully cleaned; and this everything means implements, utensils, musical instruments, and objects of recreation.

Meat and milk are not a very prolific source of implantation of tuberculosis in human beings, and yet it is proper that even this avenue of danger should be cut off. Tuberculous meat should be condemned and confiscated in the slaughter-house; and tuberculous milk should be beaded off at the dairy by permitting milk from tested herds only to be served to the community. The public should, moreover, be advised to cook or roast all meat and to scald all milk before consuming it.

For the other measures of public prophylaxis legislation will be required in federal, state, and municipal legislatures; and it is part of the honorable calling of the medical profession to help bring about such legislation.

The most important, the most far-reaching, and fortunately also the most humane of the remaining measures are the establishment and maintenance of hospitals and sanatoriums for the treatment of the tubercular poor. A little has been done in this direction. The United States has established a sanatorium for the treatment of its tubercular soldiers and marines; Massachusetts has established a sanatorium for tubercular subjects who are able to contribute a trifle to their own support; New York has established a sanatorium which is to be supported by counties; Pennsylvania biennially makes a small appropriation for maintenance of tubercular subjects in a private hospital for such cases; and New York City, Chicago, and possibly other cities make appropriations for the maintenance of tubercular subjects in private hospitals. The United States might well go farther and establish large sanatoriums on some of the public lands, at least, for federal employés of every kind who have contracted tuberculosis whilst in the Government employment, and it would probably not go too far in extending the benefits of such sanatoriums to any of its legitimate pensioners. Every State and Territory in the Union should establish sanatoriums for incipient cases. Commonwealths should be made to see in this a duty rather than a charity. When a person contracts tuberculosis his life is jeopardized by a disease which is preventable, and which the State is in duty bound to prevent. In equity at least, the State owes it to that man to try to help him save the life which has been jeopardized, and that help can best be extended through a sanatorium. By the establishment of such sanatoriums the State would, moreover, create the very best machinery for the prevention of the disease. Not only could it thus pay its debt of justice to those whom it has injured by dereliction, but it would also at the same time prevent injury, for the future, to those whom it is bound to protect. Municipalities and, in country districts, counties should establish hospitals for advanced cases of tuberculosis or consumptives. Such cases can rarely be restored to health; but they are entitled to the best chances of recovery which science can give and to such alleviation of suffering as humanity dictates. Great sacrifices are demanded of them for the protection of the public; and these sacrifices add materially to their sufferings both mental and physical. What better return can a community make for the benefits which it derives in exemption from the disease, than an asylum in which the sufferings of the afflicted may be mitigated? Besides, the community, after all, becomes the chief

beneficiary of the hospitals in the security which it gains. It is possible to teach and to train the poorest and most ignorant consumptive to make himself harmless to those about him in a hospital, but in his home this cannot be accomplished even under the most efficient board of health. Communities will, moreover, find it profitable to provide hospitals for the consumptive poor as a check to poverty and pauperism. Among the working-classes tuberculosis always leads to poverty and frequently to pauperism. Many families nobly struggle under the burden unaided until the last member has gone to his grave, but others go to pieces on the rock of debauchery, where the bread-winner seeks to forget his sorrow, and its members are scattered into almshouses and eleemosynary institutions.

The exclusion of tubercular subjects from occupations in which they can contaminate food, wearing-apparel, and implements will require legal enactments before it can be brought about in practice. Under existing law, boards of health could no doubt quarantine tubercular subjects, and thus exclude them from occupations of any kind; but this would be a most cruel as well as a most expensive method, and would in the end defeat its object. A more practical, a less expensive, and a more humane way of bringing about the end in view would be a legal enactment prohibiting the employment of tubercular subjects in certain occupations. That such a law would be justifiable there can be no doubt; but it will require much public enlightenment to get it enacted. In the interest of humanity it is to be hoped, too, that it never will be passed until public opinion will at the same time not only sanction, but also enforce legal enactments pensioning every tubercular subject who is deprived of his occupation and every person dependent upon such tubercular subject for support. Our government has never hesitated to provide liberally for those persons and their dependents who have endangered their lives in war for the good of their country. Why should it hesitate to provide for those whom it asks to make an equal, if not greater, sacrifice in time of peace? In the light of science, the tubercular subject, if deprived of his occupation, has a better claim upon the government than the soldier, because (1) his chances of death from a disease, against which the government owes him protection, are greater than are the chances of the soldier from accidents of war and diseases of war combined; (2) he makes his sacrifices for the public good without emoluments or glory, whilst the soldier receives a modicum of each; (3) he has no resources for a living during his illness, whilst the soldier is fed and clothed by the government while employed. Both equity and humanity demand that, if ever the tubercular subject be deprived of his livelihood, he and his dependents be made wards of the public treasury.

Regulation of emigration and migration of tubercular subjects ought to be entrusted entirely to the federal government. The immigration of tubercular subjects from a foreign country and migration from one State to another should undoubtedly be restricted; but its absolute prohibition would be an unnecessary hardship. There can be no good reason for interfering in any way with the movements of persons in the incipient stages of tuberculosis, unless there is a likelihood of their becoming a public charge. A person in the early stages—that is, before necrosis and cavity-formation set in—cannot convey the disease to others; and he has fair prospects of recovery before the contagious stage may set in. Why should impediments be placed in the way of his recovery and on what just ground can he be deprived of his liberty? Inasmuch, however, as he is suffering from a disease which may go on to a contagious stage and to a fatal termination, a community undoubtedly has a right to inquire into his financial ability to maintain himself and to make himself harmless to others, if the disease should become contagious, before receiving him, and to object to his coming, if he is unable to show that he can do so. Emigration and migration of tubercular subjects in the early stages should, therefore, be based upon the ability of a person to take care of himself; and laws upon the subject should be uniform. When the tubercular subject has advanced to the contagious stage there is just ground for depriving him of his liberty to go where he will, but even then his movements should be regulated rather than prohibited. The migrations of dying consumptives from State to State and from Territory to Territory, in search of a climate that will restore them to health, only to die at last among strangers and become a public charge, is a cruel practice born of ignorance, and cannot be prohibited too radically. But when a tubercular subject who has advanced to the contagious stage can give satisfactory proof that he is entirely competent to take care of himself, and that his habits and the individual prophylaxis which he practises are such as to make him absolutely harmless to others, there is no good reason why he should not be licensed to go where he pleases. All that the public has a right to demand of him is protection against every possible source of contagion, and in exacting that protection it may not interfere more than is necessary with his personal rights. Much embarrassment and suffering will be avoided by entrusting the entire matter of regulation of movements of tubercular subjects to the federal government, as thereby uniformity of practice will be obtained. States, no doubt, have the right to make laws on the subject; but in the interest of the general good they should refrain from doing so.

The regulation of the sale or gift of articles which have been used or handled by tubercular subjects may already be within the powers

of boards of health; but even if it is, its accomplishment should be expedited by legal enactment. It should be made a misdemeanor to sell, give away, or permit to be used any article which has been used or handled by a tubercular subject who is in the contagious stage of the disease, unless such article has been sterilized. Kind-hearted thoughtless people often give away the clothing, furniture, tools, books, objects of recreation, etc., of consumptives, without sterilization; the more thrifty sometimes sell such articles to second-hand dealers; employers usually permit the tools of a consumptive to go into the hands of a new employé without sterilization; storekeepers constantly permit tubercular subjects who are in the contagious stage to sell merchandise; and manufacturers permit tubercular subjects who are in the contagious stage to work on and handle products which go into the homes of people either as clothing or food. By all of these practices contagion is distributed; and no doubt many successful implantations of tuberculosis occur in this way. In a sense such a law would be a ban upon charity; but there is no charity in a gift which may have death concealed in it and the charity of the employer to the tubercular subject is more than counterbalanced by the injustice to the consumer. Charity to the tubercular subject should take another form.

Something has already been done for the extermination of tuberculosis in dairy cattle and domestic animals. A number of States have enacted and in a measure are enforcing laws for the detection and extinction of tuberculosis in dairy cattle. The form which the law has taken, where it exists, is subjection of suspected herds to the test with tuberculin and condemnation for slaughter with part compensation by the State for all animals which give a positive reaction. The law is a State law, and is enforced by State officers. It would be much better if the whole matter were left to the federal government and uniform laws for the entire country were enacted. With diversified laws and spasmodic efforts in some localities while nothing is done in others, much useless sacrifice is entailed, for tuberculosis can never be stamped out effectually among dairy cattle, except by a universal effort throughout the entire country. Something ought also to be done to stamp out tuberculosis among domestic animals of any kind. Probably the most practical way of accomplishing this would be to offer a scalp bonus on domestic animals which have reacted to the tuberculin test in the hands of an officer of the law and have been killed. But it is not sufficient merely to destroy animals which already have tuberculosis. The sources of contagion from human beings to animals should be stopped. Whatever doubt there may be about the conveyance of tuberculosis from animals to human beings, there can be no doubt about the conveyance of the

disease from human beings to animals. Laws, with penalty clauses attached, should be made, prohibiting the employment of tubercular subjects in any capacity about domestic animals, and particularly in dairies and poultry-yards.

A good deal has already been done and is being done in the restriction of spitting. Many small towns have passed ordinances prohibiting expectoration on the streets and in public places, and imposing a fine upon the person who disobeys the ordinance. Such ordinances are passed under the powers of boards of health and of police, and have been adjudged good law by lower courts. There is some danger of unfounded fear carrying the public too far in its crusade against spitting. The expectoration of mucus and of necrosed tissue in diseases of the lungs and upper air-passages is as necessary and as unavoidable as the voidance of urine and the defecation of fæces. It is likewise just as necessary and important in the interest of public health and decency that the matter expectorated be disposed of without offence or injury to others as it is with urine and fæces. But the remedy lies not in the prohibition but in the regulation and restriction of spitting. The ingenuity of man must find some way of disposing of expectorated matter that will be convenient, decent, and innocuous, and the burden of inaugurating new habits and customs should not be placed upon the weak, the sick, and the helpless. Instead of making laws with penalties attached prohibiting expectoration, an educational movement against spitting should be inaugurated and vigorously prosecuted; and the consumptive poor, with whom expectoration is a necessity, should be supplied with means for disposal of expectorated matter. A number of contrivances have been devised for this purpose, such as paper spit-cups and pocket-flasks; but all of them are luxuries which a poor man cannot indulge in. Even the paper napkin and paper bag, which probably constitute the cheapest receptacle for expectorated matter while on the street, are beyond the reach of the poor. Expectoration into the ordinary handkerchief is a much more dangerous practice than expectoration upon the street, or even upon the pavement, because the necrosed tissue which is deposited in a handkerchief quickly dries, and when the handkerchief is subsequently used is deposited on the clothing of the patient, to be scattered by him wherever he goes; whilst the necrosed tissue which is deposited upon the street is soon reduced to elementary principles and devitalized by water, sun, and air. A method of disposing of expectorated matter, worth thinking about, would be placing large stationary spittoons containing a germicide in secure places along the street, convenient distances apart either under the supervision of the police or of special officers. The spittoons might even be connected with the sewer and have water

intermittently passing through them for the purpose of flushing them, thus doing away with the necessity of a germicide. Incongruous as such a method may at first sight appear with our ideas of police patrol, it is probably not more so than the collection of garbage and the removal of sewage were to our ancestors, and there is just as good reason for it.

Public Hygiene.—Besides public prophylaxis as a factor in the prevention of tuberculosis, we have public hygiene: the one has to do with the germ, the other has to do with the soil. Tuberculosis is due to a vegetable parasite, but that parasite requires a congenial soil for its development; public prophylaxis seeks to destroy the germ and to prevent its entrance into new hosts, whilst public hygiene seeks to destroy soil and to immunize those who have to come in contact with tubercular subjects. Soil for the tubercle-bacillus is of a diversified character, depending upon racial and family proclivities and upon individual development and condition. Except in so far as soil is influenced by the laws of acclimatization, it may be laid down as a general proposition that whatever makes for degeneration and deterioration in the human organism makes for soil for the tubercle-bacillus, and that whatever makes for physical development and building up makes against soil and for immunity. Public hygiene becomes instrumental in the prevention of tuberculosis through drainage, regulation of the width of streets, regulation of smoke and dust, regulation of air-space in houses and factories, and regulation of working-hours and working-age.

Moisture of soil and dampness in and about dwelling-places are very conducive to the development of tuberculosis. Just how these factors work and what part they play we do not know, but we have ample clinical evidence to show that they play an important part; and the clinical evidence has been gathered as well from the country farm-house as from the city residence. Proper selection of location of houses in the country and good drainage with properly paved streets and sidewalks in towns and cities should be under police patrol, and not left to the ignorance and whim of the individual. In large cities this in a measure is the practice, but even in the best governed cities the drainage of cellars is left to the individual.

Sunlight is nature's best and most useful germicide. The germicidal powers of sunlight are particularly potent on the tubercle-bacillus. Air is likewise an excellent germicide for the tubercle-bacillus. Wide streets, which will admit of sunlight and air, are therefore important factors in preventing the spread of tuberculosis, and should be established in all large cities. In old cities, in which the width of streets can no longer be changed without too heavy expense, sunlight and air may be supplied in the closely built-up portions in a measure

by removing buildings from certain localities and establishing public squares. All blind streets and alleys—that is, streets which have but one outlet—should be cut through. In cities in which apartment-houses and tenement-houses exist the law should carefully and jealously exact ample air-space and light on all sides and upon every external surface of buildings, and guard against interiors which have no direct communication with the exterior. Stagnant air-wells should, above all, be guarded against, and where natural ventilation of air-wells is impracticable artificial ventilation should be insisted upon.

Smoke and dust exercise a predisposing influence in the development of tuberculosis by irritating the mucous membrane of the respiratory tract, and probably also by interfering with oxidation of the blood. As far as practicable and consistent with the commercial interests of a community, smoke and dust should be prevented. In manufacturing cities high chimneys for factories should be insisted upon, and every device possible for the complete combustion of carbon should be exacted. For the abatement of the dust-nuisance well-paved streets with a properly organized and a well-equipped street-cleaning department are the best measures. There is even a much stronger reason for keeping down dust than for avoiding smoke, because the dust has mixed with it the contagion-bearing matter which is expectorated from thousands and hundreds of thousands of respiratory tracts, affected by some form of disease ranging from a mere cold to confirmed consumption.

Air is as essential and important a factor in healthy living as food. No difference what other favorable conditions may surround an individual, unless he has plenty of good fresh air it is not possible for him to maintain perfect health. The air not only furnishes the oxygen for oxidation of the blood, which is an essential factor in nutrition, but also carries off carbonic acid gas and other products of combustion which if they were permitted to remain in the organism would poison it. Very few individuals fully appreciate the *rôle* which air plays in their physical well-being and happiness, and even those who do appreciate it, when they live in cities, cannot always control the amount of air-space at their command. It is, therefore, proper that the government should regulate the quantity of air-space for each person in dwelling-houses, factories, and public places. No walls should be erected for the enclosure of human beings without the State having a voice as to how many cubic inches of air-space shall be enclosed for every human being that is to be either temporarily or permanently sheltered within those walls.

One of the strongest predisposing causes to tuberculosis is exhaustion of vital force. The moment a human being uses up more

energy than his organism can make he prepares himself for the onslaughts of parasitic life, and particularly of the tubercle-bacillus. It is probably in part at least for this reason that tuberculosis is to such a great degree a disease of the poor and of the working-classes. Whilst it is not possible for the government to regulate the amount of energy which the individual may use up, it is practicable and proper that the government should place a limit upon the number of working-hours which the employer may exact from his employé. In fixing the time for work the law should make ample allowance for rest and recreation. Protection should also be thrown around youth in the matter of physical labor, as well as of intellectual development; for exhaustion of vital force during the developmental period is bound to have a disastrous effect upon the entire life of the individual. Children in whom the nutrition which ought to go to growth and development is used for physical effort and intellectual training will always fall easy prey to disease in adult life, because their constitutions have been badly built up. Education should not be begun too young nor pressed too vigorously before second teething has been completed; and severe physical strain should not be permitted until after full bodily growth has been attained. Child-labor in every form other than that which merely carries with it light physical exercise should be absolutely prohibited.

Private Prophylaxis.—Private prophylaxis in tuberculosis is of two kinds: that which is to be practised by the sick and that which is to be practised by the well. Prophylaxis which should be practised by the sick may be subdivided still further into that which is in the interest of self, and that which is for the protection of others.

Prophylaxis on the part of a tubercular subject in the interest of self is one of the most important factors making for recovery in the treatment of tuberculosis. Without it recovery is almost hopeless. In every case of tuberculosis there is an effort on the part of nature to bring about a cure, and this effort would nearly always be successful if it were not for autoinfection. Unfortunately, the very process which nature mostly uses to bring about a cure is fraught with danger. When a tubercular deposit has taken place, the road to recovery lies either through absorption, through encapsulation, or through necrosis of the deposit. Most frequently it follows the course of necrosis. In this way nature seeks to eject the parasite from the economy and thus end the struggle. In the process of ejection ulceration through healthy tissue takes place, and the necrosed tissue, containing myriads of living germs, has to pass out along routes which readily admit of the re-entrance of the tubercle bacillus. For example, when the disease is in the lungs there are three points along the avenue of exit at which re-entrance of the bacillus into the system may take place:

(1) at the point of ulceration, (2) through the respiratory tract, and (3) through the alimentary canal. Over re-entrance at the point of ulceration the patient has no control; but over re-entrance through the respiratory tract and the alimentary canal he may exercise control. Re-entrance through the respiratory tract is not likely to occur at the time of exit of the necrosed tissue, but is liable to take place later. The moment the necrosed tissue gets free into the bronchial tubes a spasm of the involuntary muscles concerned in respiration takes place to eject it. It is after ejection, when the necrosed tissue has dried and become pulverized into a fine dry powder and again finds its way back into the respiratory tract, that there is danger of the bacillus getting back into the system by way of the lymphatic system. Re-entrance through the alimentary canal may take place both at the time of ejection of the necrosed tissue and afterward when the tissue is dry and pulverized. The prophylactic measures which a patient should practise to protect himself are: (1) complete expectoration of necrosed tissue the moment it becomes free in the bronchial tubes; (2) careful cleansing of the pharynx and nares at certain intervals, and especially before eating; (3) immediate sterilization of all necrosed tissue the moment it is given off. Expectoration of necrosed tissue will usually take place naturally, provided it is not interfered with by opiates. Opium should, therefore, not be given in tuberculosis except when the cough is excessive and irritating. Sometimes, when the necrosed tissue is not given off as freely as it should be, ammonia will assist in its ejection. For cleansing of the pharynx an astringent gargle is very serviceable, and if a mild germicide power is given to the gargle all the better. The nares should be kept free and aseptic: by douches; by occasional insertion of pledgets of cotton saturated with a solution of europhen or iodoform in a mixture of olive oil and some of the essential oils, such as oil of thyme and oil of eucalyptus; and by inhalation through the nose of volatile substances which have aseptic properties, such as iodine, creasote, turpentine, benzoine, etc. For the immediate and complete sterilization of necrosed tissue, probably the best method is to have the patient, under all circumstances when indoors, expectorate into a vessel containing a germicide solution, and wipe the mouth with a paper napkin, the napkin to be deposited in a paper bag or some other receptacle until it is convenient to have it burnt. When out of doors or in places where vessels for deposit of sputa are not at hand, expectoration into paper napkins should be practised, and the napkins deposited in a paper bag or a chatelain until an opportunity presents itself for burning them. Never under any circumstances should a patient expectorate into an ordinary handkerchief of silk, linen, or cotton, because the expectoration speedily dries in such fabrics, and when the handkerchief is subsequently

used the dry sputa is liable to be inhaled with the inspiratory effort which precedes expectoration, and having been set free in the air be deposited upon the patient's clothing and the material objects in his environment, to be again inhaled by himself and others when the dust upon his clothing or such objects is disturbed. Patients should also be made to understand that spitting even upon the street and in public places may prove prejudicial to themselves, because they as well as others have to inhale the air in those places, and they may again take in some of the germs of which nature has rid them.

Prophylaxis on the part of a tubercular subject for the protection of others is practically accomplished by the same measures which are necessary for the protection of the patient himself. There are, however, a few minor precautions, in addition, to be taken in the interest of others. The social customs of handshaking and of kissing ought to be rarely indulged in by a tubercular subject, because, no difference how cleanly he may be in his habits, his hands and lips may become contaminated sufficiently with necrosed tissue to be a source of danger to others in such intimate relations. For the protection of relatives, utensils for eating and drinking should be kept separate or apart, and should be washed separately. This is an extreme precaution which may be superfluous except as a matter of discipline, and yet as such it is of importance, because it will prevent carelessness which would otherwise almost certainly occur during the long course of the disease.

Prophylaxis in tuberculosis, which should be practised by the well, principally concerns those who have to be thrown in intimate contact with tubercular subjects. Could one always feel certain that tubercular subjects are doing all that is required of them for the protection of themselves and others, nothing would remain for persons to do who come in contact with them ; but such care on the part of tubercular subjects is rarely taken in practical life. Prophylaxis on the part of the well is therefore necessary. It consists in guarding against the entrance of necrosed tubercular tissue into the system (1) through the respiratory tract and (2) through the alimentary canal. The barring out of this tissue can, of course, be most readily accomplished by guidance and superintendence of the personal prophylaxis of the patient so far as this is possible. Where that falls short it must be supplemented by scrupulous cleanliness on the part of attendants. Any necrosed tissue that may escape sterilization when it is given off and is ejected upon the patient's clothing, upon bedclothing, upon furniture, or carpet, should at once be taken up carefully with a cloth saturated with some germicide solution and burnt. A rag dipped in a strong solution of carbolic acid or corrosive sublimate may be used for this purpose. Every possible precaution

should be taken against creation and distribution of dust in the environment of a tubercular subject. When one is much in an atmosphere in which necrosed tissue may float about, one should be very careful to breathe through the nostrils, and at convenient intervals should cleanse and sterilize the nasal passages. Breathing through the nostrils in itself gives fair protection by reason of the many obstacles to the introduction of foreign bodies which nature has placed in the upper air-passages. Besides the danger from intimate family relationship with tubercular subjects, there is danger of contracting tuberculosis through the respiratory tract when people take up their abode in houses which have been occupied by tubercular subjects or unknowingly come in intimate contact with fomites laden with necrosed tubercular tissue. Under such circumstances persons may not be aware that they are in danger, and therefore there is no precaution which they can take. It might be well, however, for people, before changing their places of abode, to inquire carefully into the history of the dwellings into which they are about to move, and also for them to exercise some circumspection in the purchase of clothing and food with a view of excluding as far as possible objects from their households which have been contaminated with necrosed tubercular tissue.

Against entrance into the system of necrosed tubercular tissue through the alimentary tract greater care is even necessary, than against entrance through the respiratory tract. This applies both to those who are in intimate association with tubercular subjects and to people at large. In the home of a tubercular subject, even when ordinary care is taken and cleanliness is maintained, it is an easy matter for those who are waiting upon the sick person to contaminate their food with tubercular tissue. In the many little domestic relations which must exist between the well and the sick the hands of the attendants are liable to become contaminated, eating- and drinking-utensils may become contaminated, and even food itself may have necrosed tubercular tissue mixed with it. For these reasons the well should observe certain fixed rules from which they should under no circumstances deviate. These rules are: (1) not to eat or drink anything without having previously washed the hands and cleansed the lips; (2) scrupulously to avoid using the same eating- and drinking-utensils that have been used by the tubercular subject; (3) to exclude the tubercular subject from the larder and kitchen. These rules at first sight seem hard, difficult of application, and supererogatory; but they will not be found so in practice and in the long run. In their enforcement every care should be taken to spare the feelings of the patient, so as not to isolate him in the bosom of his own family. With this end in view, he should be fully informed of the

significance of all that is done. With people at large the chance of the tubercle-bacillus gaining entrance into the system through the alimentary canal exists when food has been contaminated commercially and when it has been contaminated naturally in domestic animals. So long as tubercular subjects are compelled to earn a living and to seek occupation in every walk of life, there will be danger of tuberculosis being spread through food because of the commercial relations which exist between men and men. Tubercular subjects are engaged in every occupation which has to do with the preparation and purveyance of food, and under existing conditions it is practically impossible for people to protect themselves against danger from such sources. Some circumspection should, however, be exercised by everyone in the purchase of food and in domestic management, with a view of guarding against such danger. Besides, all food which is eaten in the raw state ought to be carefully washed before it is eaten. Natural contamination of food in domestic animals takes place in milk and meat of tubercular animals. What the danger from this source amounts to we are as yet unable to determine definitely, as reliable clinical data are wanting and there is a wide divergence of opinion among experts upon the subject. Until the matter has been determined, safety lies in discretion; hence all meats should be cooked or broiled, and all milk should be scalded before using. For milk, heating to a temperature somewhat below the boiling-point is sufficient.

Private Hygiene.—The individual who desires to avoid contracting tuberculosis must not only maintain a vigilant guard against the entrance of the tubercle-bacillus into his organism, but must seek to develop and keep up a resisting power to it. This resisting power we call immunity. Immunity to tuberculosis may be natural and acquired. Natural immunity varies in degree both in individuals and in races, and cannot be changed by individual effort; but acquired immunity is largely at the command of the individual. For the acquirement of resisting power to tuberculosis private or personal hygiene is the principal means. Personal hygiene means healthy living or constant observance of the laws of health. This healthy living, to be effective to the fullest extent, must antedate the individual and have been practised for him by proxy in his ancestry for generations. What has been lost through ancestry cannot be entirely taken up by the individual, although it can be regathered for future generations; but much can be done by the individual toward regaining it. Healthy living means living according to the laws of nature: plenty of fresh air; good food—not too much nor too little; proper clothing; physical activity; intellectual employment and recreation within proper bounds, and ample sleep. Excesses and

extremes of all kinds must be avoided, and moderation and regularity made the guiding principles of life. For those who have lost stamina in the shortcomings of ancestry, outdoor life offers the best arena for physical well-being. Air is the most essential and most important substance in the conservation of life. It is the substance which one cannot suspend the use of for the briefest period without ending life. It is not to be wondered at, therefore, that its use exercises a greater influence upon health than any other factor. Nature gives a bounteous supply of it, so that everyone may have plenty of it without cost or labor; and it has the most facile power of ridding itself of impurities which are prejudicial to life. Strange as it may seem, civilization has been a conspiracy against man's free and unhindered use of this greatest of God's gifts. The individual who wishes to maintain such immunity as he may possess against tuberculosis, or to acquire more, must free himself from the trammels of civilization and see to it that he gets plenty of air night and day, and that he gets it free from impurities. Above all things should he avoid rebreathed air, as such is filled with poisons given off from his own organism or the organisms of others, and has been deprived, to a greater or less extent, of the ingredients necessary for the maintenance of life. Night air, damp air, cold air, any kind of air, indeed, which comes from out of doors, is good when compared with the air of an enclosure, because enclosure takes from air its power of ridding itself of impurities. Living-rooms, working-rooms, and sleeping-rooms should, therefore, never be shut off from communication with outside air, and the amount of communication should be regulated according to the temperature within and without the room and the number of persons in it. The traditional fears of exposure to night air, cold air, and damp air are bugaboos engendered in the fancy of ignorance.

Next to the use of air, use of food is the most important factor in healthy living. With food mistakes are constantly made in variety, preparation, and quantity. Man is an omnivorous animal, and can select his food from a very great variety of the products of the earth both in the animal and vegetable kingdoms. This adaptability leads to two dangers: taking too much food on the one hand, and an insufficient variety on the other. Man should change his diet from time to time, and at all times have some variety in it. A good plan is to have different kinds of food for the different meals of the day, making farinaceous food the principal feature of the breakfast, albuminous and leguminous foods the leading features of the dinner, and fruits the feature of the supper or lunch. One of the most frequent mistakes is taking albuminous food in large quantities and in different forms at each of the three meals of the day. Preparation of food is

for the purpose of making it more digestible, thus economizing energy in the organism. Unfortunately, the pernicious practice of over-eating has led to the sacrifice of this primary object to a squeamish palate. Digestibility and not palatability should be the aim of good cooking. As a general principle, no food should be so prepared as either to deprive it of its nutritive qualities or load it down with an impediment to the action of the various digestive secretions. Above all things, starchy food should not be soaked with fat. In the interest of good health the frying-pan should be banished from the kitchen. As to quantity of food, there is greater danger of too much being taken than too little. Except among the very poor, the majority of people eat more food than is consistent with good health. This over-feeding sets up malnutrition by introducing into the system poisonous products of incomplete combustion, and malnutrition is one of the strongest predisposing causes of tuberculosis. Most people eat three full meals a day, although few people can digest three full meals. The result is that digestion with each succeeding meal having become more labored, the last meal is liable to ferment and decompose instead of being digested, because of failure of the digestive fluids to act; and with the products of this fermentation and decomposition circulating in the blood and invading every organ in the body, weakness, lassitude, and physical incapacity become the bastard offspring of a night's sleep. Nothing could be more conducive to the preparation of the human organism as a culture-medium for the tubercle-bacillus. Individual powers of digestion should be made the gauge of the food to be taken, and where those powers are below normal the deficiency should be made up by the selection of food which is more digestible. Excessive use of alcohol is a predisposing cause to tuberculosis, and should be avoided. By excessive use is not meant drunkenness, but such use as will interfere with normal circulation and bring about changes in the tissues of important organs.

Proper clothing means such covering of the body as will, without impeding the functional activity of important organs, conserve heat and protect against exposure and injury. The most frequent mistakes about clothing are, dressing too warmly in winter and dressing in a way to interfere with the functions of important organs. During the winter clothing should never be so warm as to relax the body and freely open the pores of the skin. Provision should be made for the change of temperature from within doors to without.

Physical activity is an essential factor in a régime for good health. In antithesis to use of food it is most frequently sinned against on the side of insufficiency rather than overindulgence, although it may be followed to excess. The locomotive department of the human organism, and especially the muscular system of it, is the largest and

one of the most important in the body, and in the economy of the organism provision is made for its consumption of a large amount of force. When this force is not consumed and the force-producing machinery of the organism is kept going at full blast, clogging and damage are bound to result somewhere. Usually the digestive system, especially the eliminative organs, and the circulatory system, bear the brunt of injury, and we have as a result the dyspeptic, who is a proverbial candidate for tuberculosis. People whose avocations do not give them physical activity should form habits of taking physical exercise systematically either in walks, drives, horseback-exercise or gymnastics. At the same time they should adapt their food to their avocations. Excessive physical activity is apt to occur with athletes and persons who follow laborious occupations. The injury, in excessive physical activity, comes to the circulatory system, creating thereby a predisposition to tuberculosis.

The nervous department, like the locomotive department, of the human organism is destined in the plans of the economy to consume a large amount of force. Intellectual activity is therefore likewise essential to health, and this activity should take the forms of employment and recreation. It is because of the broad and diversified capacity of the human brain that recreation is necessary. Employment is apt to lead into a rut which recreation diverts from. Intellectual activity may be deficient or excessive, and in either event prejudices the organism and predisposes to disease. Deficient intellectual activity may lead to dissipation and melancholy by diverting too much force to the reproductive system and the sympathetic nervous system; whilst excessive intellectual activity is liable to disturb the digestive and circulatory system by diverting too much force from them to the brain and thus interfering with nutrition. Persons whose avocations entail physical labor should cultivate their minds, and persons whose callings give constant occupation for the brain should seek diversion in physical exercise, as an even distribution of force is necessary for physical well-being and happiness. Unhappiness, strong mental disturbance, and disappointment are among the traditional predisposing causes of tuberculosis. Whatever foundation they may have in fact is no doubt due to the bad health which leads the van of an unsound mind.

Sleep is nature's balm for all the sores of mind and body. It is the time of rest and recuperation of both the locomotive department and the nervous department. Without it, and ample of it, health cannot be maintained. Loss of sleep has a bearing upon tuberculosis only in so far as it depresses the nervous system and impairs nutrition, but in this way it no doubt may become a predisposing cause of the disease. It most frequently works its injury in youth, when

sleeping-hours are apt to be sacrificed to pleasure and dissipation. For the maintenance of health sleep should be taken at regular hours and in definite quantities, during the quiet hours of the night. From six to ten hours is the amount usually required, according to age and idiosyncrasies.

Treatment of Predisposition.—Predisposition to tuberculosis is a tendency to the development of the disease over and above that possessed by the average individual. It is the opposite of immunity. It may be inherited or acquired. Inherited predisposition may be derived from racial or family proclivities. Acquired predisposition is necessarily individual. Predisposition being a quality of the body, can be transmitted consistently with the laws of physiology, in which regard it differs from disease, which, being an independent entity, cannot be transmitted. Just what constitutes predisposition we are not yet in a position to determine. It may be something in the organism which makes good soil for disease-germs, or it may be something missing from the organism which if there would resist disease-germs.

Racial predisposition is well illustrated in the American Indian and in the Negro. Both of these races were entirely free from tuberculosis prior to contact with the white man, showed strong predisposition when they first came in contact, and give evidence of diminished predisposition after exposure for several generations. This would appear to indicate that they either offered good soil or lacked resisting power in the beginning, and that with exposure the soil became exhausted or they developed resisting power. Family predisposition is much like racial predisposition, and is no doubt subject to the same fundamental laws. Prolonged exposure to tuberculosis in a family seems to set up immunity of temporary duration. Individual predisposition may be due to deformity of the body, to pathological conditions, the result of other diseases which weaken individual capacity for health and struggle for existence, or to functional incapacity due to loss of stamina, the result of inherited dyscrasia, personal dissipation, depraved environment, want, or overwork. Acquired predisposition to tuberculosis is sometimes erroneously called the pretubercular stage of tuberculosis, a nomenclature which is both self-contradictory and misleading.

In the treatment of predisposition to tuberculosis our object must be, first, to remove the tendency to disease; and, secondly, to regulate the individual's life so that he may be exposed to the disease as little as possible. Racial and family predisposition are practically irremovable, as they may exist with perfect health. Persons with such predispositions should maintain good health and keep away from tuberculosis. Casual contact with tubercular subjects need not be

feared, but intimate association for a long period of time should be avoided. When tuberculosis occurs in a family in which racial or family predisposition exists, the case had better be removed from the bosom of the family into a hospital or sanatorium before the disease has reached the contagious stage. In individual predisposition, much can be done to overcome it. If the predisposition is congenital, every effort should be made from babyhood up to supply to the individual the stamina which he has lost through his ancestry. For such children outdoor life in the country, and if possible in a well-selected climate, should be prescribed, and special care should be given to their nutrition from the very start. Their school-days should be postponed to as late a period in life as possible, and even when their education begins it should be made secondary to physical development. Such children should be kept away from tuberculosis during their growing years, and should be fully imbued with the importance of maintaining a vigorous condition of health through life and avoiding exposure to the disease. Where individual predisposition is due to deformity or to pathological conditions which are the result of other diseases, every effort should be made to overcome the incapacity thus created. If there is a deformed chest due to bone disease, the chest should be systematically developed from childhood up; if there is a damaged heart, life should be regulated so as to develop and maintain compensation; if there is a blood dyscrasia, due to some defect in the blood-making system, every energy should be bent in the direction of improving the blood and restoring the injured parts to a normal condition; if there is a defective digestive apparatus the result of inflammatory condition or of depraved habits of eating, the injured organs should be repaired and the bad habits corrected; if there is injury to the reproductive organs, which by reflex irritation interferes with nutrition, these organs should be promptly restored to a normal condition; and if there is an impediment in the upper air-passages to normal respiratory capacity, such impediment should be removed. Besides restoring persons thus incapacitated to normal conditions, or as near normal as possible, it is well to instruct them carefully about the contagiousness of tuberculosis and about the manner in which the disease is conveyed from one person to another, and to advise them to avoid exposure to the disease as much as possible. Forewarned in such cases is forearmed, and what cannot be made up to them in complete restoration to normal condition may be supplied by an intelligent understanding of danger and avoidance of it. Predisposition which is due to want, overwork, and depraved environment can only be overcome by social reforms.

CURATIVE TREATMENT.

THE curative treatment of tuberculosis has to do with the eradication of the tubercle-bacillus from the host and the reparation of all damage done. In a study of the curative treatment it is therefore necessary to keep in mind the main facts about the pathology of the disease and the biology of the organism which produces it. About the pathology these are: (1) that tuberculosis is due to a parasitic germ called the tubercle-bacillus; (2) that other organisms besides the tubercle-bacillus coöperate in the devastation set up during the disease; and (3) that whatever tissue-changes take place during the course of the disease are due either to the organisms concerned in the disease, to nature's effort at repair, or to physical damage done to important organs. It is true there are some who still doubt the agency of the tubercle-bacillus in tuberculosis, and who claim that the germ is rather a result than a cause; but the vast preponderance of authority is on the side of the tubercle-bacillus being the sole essential cause of tuberculosis, and no other view is reconcilable with the clinical phenomena which the disease manifests, when studied as a whole. About the biology of the tubercle-bacillus such facts are: (1) that the tubercle-bacillus can maintain viability for a long time in a dormant state; (2) that it has a long incubation-period; (3) that for its cycle of life colonization is necessary; (4) that it is virtually a parasite; (5) that its life is circumscribed by fixed conditions.

There are also certain general pathological and biological principles which throw light upon the subject. These are: (1) that all germ-diseases are due to the parasitic life of living organism; (2) that there is in all living organisms an inherent power of protection against parasitic life; (3) that the power inherent in the human organism protective against disease is potent in direct ratio to normal physical development and normal standard of health; (4) that a proper soil for a given disease-germ must exist in a prospective host as a prerequisite for the establishment of the disease; (5) that the soil necessary for the subsistence and development of any given disease-germ in a host may become exhausted; (6) that the normal physical development and normal standard of health, with the consequent relative resisting power to diseases, are closely related to nutrition in the individual and in the ancestry from which the individual has sprung; (7) that congenial soil for a disease and inherent resisting power to it may both exist in the same individual at the same time.

About tuberculosis as a disease, it will prove of further advantage to keep in mind: (1) that it is essentially a local disease, and as such is slow in exhausting the soil in the host in whom it is colonizing;

(2) that as a disease in its complete symptom-complex, it is a series of colonizations, each colonization constituting a minor attack; (3) that each colonization which runs its course leaves the system of the host less competent to battle against a subsequent attack; (4) that every successive colonization is more extensive and more devastating than the preceding one; (5) that when a colony has been established cure can only take place either through the phagocytic powers of the blood for destruction of the bacilli before the circulation has been cut off in the deposit, through defensive powers of the system in necrosis and ejectment of the mature bacilli, or through encapsulation; (6) that during the process of necrosis and ejectment of the mature bacilli reinoculation may take place.

The fundamental principle underlying the curative treatment of tuberculosis is immunity. Immunity is freedom from liability to disease because of an innate or acquired condition of the system which is inimical to the development of the disease; in other words, an uncongenial soil for the germs which produce the disease. We have natural immunity and artificial immunity. Natural immunity is an innate condition and artificial immunity an acquired condition, both representing something present or absent in the blood or tissue which inhibits the colonization of disease-germs. It may be the presence of an army of defence, so to speak, which has been built up by the individual, by the family, or by a race in a struggle against a disease; or it may be the absence of a specific pabulum which has been consumed by the disease-germ during former implantations in ancestors or in the individual; and it may be both. Immunity is not a fixed absolute condition, but varies from a slight temporary resisting power to an absolute permanent impediment to disease.

Tuberculosis differs somewhat from most germ-diseases in the matter of immunity. With such diseases as smallpox, scarlet fever, and measles, natural immunity is apt to be weak, and a single attack of the disease is likely to establish absolute and permanent artificial immunity; with tuberculosis, natural immunity may be strong, but artificial immunity is difficult to establish. Natural immunity against tuberculosis is not possessed by all races and peoples, nor even by all families alike. Complete artificial immunity is very seldom attained, although a very high degree of artificial immunity may be reached by certain individuals. Such immunity is sometimes acquired from bone tuberculosis and possibly also from glandular tuberculosis. There is apparently in every case of tuberculosis a tendency to the establishment of artificial immunity, as is shown by the gradually increasing chronicity of the disease and by the degeneracy of the tubercle-bacillus as the disease advances. Could the physical integrity of the individual be maintained for a long enough period of time and mixed infec-

tion avoided, a large number of cases of tuberculosis would recover, as artificial immunity would ultimately be acquired and the germs would no longer find congenial soil for the establishment of new colonies. There are really few cases in which recovery does not take place from the first attack, and in many cases complete restoration to health follows a second, a third, and even a fourth attack. Unfortunately, however, after each attack there is lower physical tone, lower resisting power, less vital capacity, and recovery is slower and less complete, with the chances of ultimate permanent recovery greatly diminished.

Immunity is difficult to establish in tuberculosis, because the disease belongs to that class which may be termed topical diseases, in contradistinction to those which are called constitutional. Although the tubercle-bacillus finds its way into the system either through the lymph-channels or the circulation, its parasitic life and development always take place in some restricted portion of the organism where it is soon cut off and entombed in such a way as to prevent it from having much effect upon the vital fluids of the body, and not until necrosis has taken place and evacuation through ulceration begins do the biological products of the germ have much chance of getting into the blood. The influence of the disease upon soil is necessarily limited during each of the separate attacks, and only becomes of value in the aggregate after long accumulation. On the other hand, the presence of a foreign body in an important organ, such as the lungs, is very apt to interfere seriously with nutrition, both directly and reflexly, through the nervous system, and to contribute to the deterioration of the entire organism, thus preparing the soil for further inroads of the tubercle-bacillus.

The importance of immunity as a factor in the cure of tuberculosis becomes evident when we consider that the disease-producing matter is cut off from the circulation as soon as the disease has been established and can no longer be reached by remedies. It is really only during the time when the bacillus is still in the fluids before colonization takes place, during colonization and before necrosis begins, and after necrosis when the bacilli again find their way into the circulation, that direct attack can be made upon the disease. The presence of tubercle-bacilli in the circulation does not give rise to symptoms which arrest attention; even colonization may go on without recognizable symptoms, and after necrosis re-entrance of the bacilli into the blood may occur at any time during the disease, and does occur at frequent intervals; hence treatment by direct attack is impracticable. Whatever is to be accomplished must be wrought through immunity. The methods of treatment and remedies at our command are intelligible upon this hypothesis, and new discoveries can be hoped for.

By creating immunity we establish the best conditions for recovery, because we thus prevent the formation of new colonies during the long and tedious process of necrosis and evacuation of the old ones, which is nature's cure. Immunity is therefore the ultimate object of all treatment of tuberculosis: maintenance of the integrity of the organism and avoidance of complications the immediate object. Whatever makes for health and for resisting power to disease makes for recovery and is good; whatever debases health and breaks down resisting power, makes for progress of the disease and is bad. It should be borne in mind too that recovery takes place by natural process, and that for this reason nature should be followed as closely as possible and with as little interference as can be with nature's own effort to get rid of the disease. To help nature in her efforts we have (1) climatic treatment, (2) dietetic treatment, (3) dynamic treatment, and (4) medicative treatment.

Climatic Treatment.—The erroneous popular idea that there is an etiological relationship between climate and consumption has quite naturally given rise to an exaggerated idea of the value of climate in treatment of the disease. When cold, trying climates were looked upon as the chief cause of consumption, warm equable climates aptly came to the mind as the remedy because the two stood in antithesis one to the other. Later on, when dampness came to be recognized as a cause of consumption, high, dry climates just as naturally came to be sought for as the remedy. For these and other reasons the history of the climatic treatment of tuberculosis is full of paradoxes. There is scarcely a climate under the sun that has not had a reputation for curing consumption, and there is hardly a country in the world that some time or other has not had a reputation both as a good place and a bad place for consumptives. There is reason for believing that Egypt was the cradle of tuberculosis and that the disease was one of the plagues which visited that country during the exodus of the Jews; yet Egypt became a resort for consumptives during the Roman and Grecian civilization. Italy has figured as the hot-bed of tuberculosis and the Mecca of the consumptive. We have no record of the spread of tuberculosis throughout Europe, but it takes no great stretch of the imagination to watch the disease follow in the wake of the Roman civilization. The islands of the Atlantic all have had their reputation as resorts and as places to be shunned. When America was discovered every part of it was looked upon as possessing curative powers for tuberculosis. Gradually the East lost its reputation and became a place of exodus for the West. One by one every State and Territory gained a reputation as a resort, to lose it again when the disease had gained a foothold among the natives. The last place to hold this reputation was the vast territory which

came to the United States from Spanish America. This section of country had remained almost entirely free from tuberculosis during its occupation by the Spaniards, probably because, owing to the Spanish belief in the contagious theory, tuberculosis was not introduced into America by the Spaniard to any great degree. But even the Spanish-American district, since it came into the possession of the United States, has gradually lost its reputation as a health resort for consumptives, and we now view the melancholy spectacle of this last resort quarantining against tuberculosis in self-defence. In by-gone days the loss of reputation of resorts was explained upon the basis of some subtle change in the climate which, though real, was not apparent. It was thought that something intangible had been added to or taken from the climate which had lost its reputation. We now know why such places lost their reputations. It was not because of a change of climate, but because of the spread of the disease by contagion.

A careful study of the history of climatic treatment of tuberculosis and of the climates which have won and lost reputations for curative powers forces one to the conclusion that climate in itself has no great therapeutic value in the treatment of tuberculosis. But there is danger of the pendulum again swinging too far, and of the profession losing what there is of value in climate by permitting itself to be stampeded into opposite extremes by popular fears and prejudices. There is value in climate, but it must be measured by new standards. First of all, we must lay aside the idea that climate is a specific for tuberculosis, or even that it possesses direct curative powers. Its action is indirect. It should be looked upon as an adjuvant rather than as a specific, and its value should be judged by what it will contribute to maintenance of health and to the acquirement of artificial immunity. In the next place, climate should not be dispensed in too general a way, but should be adjusted to the needs of each particular case. By reason of idiosyncrasies and physical weaknesses other than those brought on by tuberculosis, some patients will do better in one climate than in another, because of the adaptation of the climate to their physical defects. A person, for example, of delicate frame and nervous construction who in a normal condition could not endure outdoor life in a cold climate, would be able to pursue outdoor life in a warm climate, and as outdoor life is of importance in a struggle against tuberculosis a warm, equable climate would undoubtedly contribute much to his recovery. Again, a person of sanguine nervous temperament with vigorous circulation, to whom a warm climate is enervating, needs a cold, stimulating climate to entice him out of doors and to keep him in the kind of life which he needs to pursue in his struggle against tuberculosis. Then, too, besides temperature there is something in atmospheric

pressure which needs to be adapted to the individual. The relationship between circulation and respiration is close, and the effect of both upon the progress of tuberculosis is marked. Circulation and respiration should be controlled as far as possible by climate. This can be done by elevation, which is undoubtedly the most potent factor in climate. The relative barometric pressure which goes with a high and a low elevation, and the range which lies between them, give the physician who understands the subject a useful resource in his struggle with tuberculosis. Too little is known about this subject. As yet, we have only general principles to guide us, but these may lead to more exact knowledge. High pressure—that is, elevation—increases respiratory effort, decreases oxidation, and in a measure inhibits circulation, although it increases heart action; whilst low pressure—that is, low altitude—decreases respiratory effort, increases oxidation, and stimulates circulation, although it decreases heart action. Upon these general principles selection of climate should be based. Persons of sanguine temperament and vigorous circulation usually do well in elevated climates; whilst persons of lymphatic temperament and depressed circulation are apt to do better at a lower elevation. Anæmic persons and persons with heart lesions, as a rule, do better at sea-level than in a high altitude; and persons with bad kidney action generally do better in an elevated climate than at sea-level. The condition of the soil must also be considered, for soil has an influence upon the progress of tuberculosis. A dry, porous soil is an essential feature of a good climate. This is so because moisture and dampness in dwelling-places are injurious to a tubercular subject. A damp soil means damp dwelling-houses, and damp dwelling-houses are prejudicial to the consumptive. Whether the climate be elevated or low, porosity of soil and good drainage of place of habitation should be considered, and only a well-drained dry location should be selected for the consumptive's dwelling-place.

While relative elevation and dryness are the important qualities of climate, there are also minor features which need to be considered, and with these one is not apt to become acquainted in reading health-resort reports. Such are variability of temperature between night and day, periodical winds, dust and sand storms, and prevalence of insects. In all high altitudes and in some low, warm climates there is a wide range of temperature between midday and midnight and between wet days and dry days, which for delicate constitutions is hard to bear, and which if not provided against may prove prejudicial. The greater the amount of sunshine the greater this variability of temperature is apt to be. In such delightful climates, for example, as those of Southern California, New Mexico, Arizona, and Texas, the change of temperature between midday and midnight is

so great as to require heavy wraps at night to guard against discomfort. One may go in his shirt-sleeves with comfort during the middle of the day, and need a heavy overcoat to keep comfortable at ten o'clock in the evening. When there are a few cloudy wet days in succession the rooms, moreover, become damp and cold, and, as few houses have conveniences for artificial heating, delicate persons have to depend upon extra clothing for comfort during such times. In the mountain regions of New Mexico and Arizona, where there is much sunshine and where the air is rarefied and dry, one may have his feet biting cold and his head burning hot during certain times of the year by standing in a shaded spot with his head exposed to the sun. In many parts of California, where otherwise the climate is exceedingly agreeable, there are daily strong winds, which are so severe in character as to cause serious discomfort to the uninitiated who have not been forewarned and forearmed. In some of the best climates of Colorado there are frequent sand and dust storms which are trying to persons in good health, and in some of the delightful climates of the South, there is at times such an even warm temperature night and day and such a heavy, moist atmosphere as to stifle all energy. In some, otherwise desirable, climates of the North there are heavy fogs, annoying insects (especially mosquitoes), sudden changes of temperature, etc. In fact, every climate which has advantages is apt to have drawbacks which are particularly noticeable to the stranger, and which may become serious annoyances and sources of discomfort. To be forewarned of these takes away their most objectionable feature, because it enables one to protect himself against them.

There are also secondary factors which enter into the question of climate. These are the comforts of life and the availability of food. Home comforts, or what must correspond to home comforts when one is away from home, and a liberal supply of healthy, easily digested food are of such importance in the treatment of tuberculosis that their value can never be outweighed by any advantage that climate itself may give. No chance should be taken in these matters, but it should be ascertained with certainty beforehand whether in a respective climate, good dwelling accommodations, and ample, good food are within reach of the financial resources of the patient about to be sent there. Unless they are, the patient had better remain at home than go to the best and most suitable climate in the world.

The physician should fully inform his patient about the character of the climate to which he is about to send him, and should give him careful instructions in regard to his mode of living while there and how to avoid discomfort and danger from peculiarities of the climate. If possible, he should also refer him to a physician at the place for

further instruction and guidance. The benefit which may be derived from climate is but too often jeopardized by the ignorance and imprudence of the patient, because he has been sent from home without proper instruction, and after leaving home he is thrown upon his own resources. Patients who seek climatic treatment, when left to themselves, invariably do themselves injury by taking too much exercise before they have become acclimated, by indulgence in improper, unsuitable food, or by inability, through ignorance of place and customs, to help themselves in matters of food and home comforts. They are, moreover, liable to overlook exacerbations of the disease which have been brought on by fatigue of travel or by change in climate, and to continue in their active careers, thus stimulating the recrudescence into an acute serious condition from which they may never recover. Many a valuable life has been sacrificed to this oversight on the part of the home physician; and much of the bad reputation which has befallen climatic treatment has been due to this abuse of a valuable remedy.

The first few days or even weeks which a patient spends in a new climate should be given to rest, no difference how well he may be, and this rest should not be broken until a competent physician expresses the opinion, after careful examination, that exercise may be safely taken. The diet during this time should be prescribed by the physician and strictly lived up to by the patient. In this way the patient gradually adjusts himself to his new environments and becomes acclimated, and when this has been accomplished he will be able to get the full benefit of the climate. Even in the matter of medication, modification of the remedies used by the home physician may be necessary, because the same medication is not always indicated for the same person in different climates, and what may do very well in one place may not do so well in another. The use and dosage of drugs may have to be modified, and even changed, and this can only be done by a physician entirely familiar with the climate in which the patient has taken up his residence.

Details about the various kinds of climate, their respective locations, and exact indications for sending patients to them, cannot be given here for want of space. It may be proper, however, in a general way to indicate a few of each of the different kinds of climate as a basis of further inquiry for those who wish to pursue the matter. Of the high, dry, rarefied climates of various degrees and qualities we have the Rocky Mountains in Montana, Wyoming, Colorado, New Mexico, Arizona, the western part of Texas, and Mexico; the Sierra Nevada Mountains in eastern California and the Sierra Madre in part of Mexico; the Allegheny Mountains in New York, Pennsylvania, Maryland, Virginia, Kentucky, Tennessee,

North Carolina, South Carolina, and Georgia; the Alps in Switzerland, Italy, and France; the Pyrenees in France and Spain; the Auvergne in France; and the Black Forest and Taunus, in Germany. In these mountains we have all kinds of altitudes, ranging from a thousand to fifteen thousand feet, and all kinds of temperatures and conditions of weather. In Colorado in high altitudes we have cities and large towns where the comforts and conveniences of modern life can be had at a moderate cost, thus giving the benefits of altitude without a sacrifice of the comforts of life. In the mountains of Pennsylvania, New York, Maryland, Virginia, North Carolina, and California we have varying altitudes within easy reach of large centres of population. In New York, North Carolina, the Alps, and some of the mountains of Germany we have sanatariums in which enclosed treatment can be had at a moderate outlay of money. Detailed information about these various places can be obtained in encyclopædias and in encyclopædic systems of medicine, such as are to be found in the library of almost every physician. Climates of lower elevation, ranging from sea-level to a thousand feet, and varying in temperature and conditions of weather, can be found in California, Utah, Minnesota, Pennsylvania, New York, Georgia, South Carolina, Florida, and Texas in the United States; in Mexico; in Canada; in the highlands of Scotland and Ireland; in the Riviera; in various parts of Italy and Southern France; in the lower mountain ranges of Germany; in the Bermudas; and in Egypt. In most of these places home comforts, and in some of them special accommodations for consumptives, are to be found. Many hotels refuse admission to consumptives. It is therefore very important, before a tubercular subject goes to a resort, that he know what hotel or boarding-house accommodations he can command. It is most cruel to have a sick person go from home and find upon arrival at his place of destination that the doors of hotels are closed to him, and that he may have to accept inferior accommodations or return home. And yet such experiences are of frequent occurrence.

But while climate is a valuable adjuvant in the treatment of tuberculosis, it is not an essential factor in the cure of the disease. There now is ample clinical evidence at hand to prove that tuberculosis can be cured in any climate; hence the day of conditioning cure upon banishment from home and friends is a thing of the past. With more exact knowledge of etiology, better methods of treating the disease have sprung up, and as the general practitioner gradually takes up these methods and meets with success he will be less disposed to send his patients from home. With patients of moderate means, home treatment is preferable to climatic treatment, and for this reason the financial circumstances of the patient should be carefully considered

in making a decision as to whether home or climatic treatment should be pursued. The medical adviser should assume full responsibility of determining this question, and when he has satisfied himself that the patient lacks financial means of properly using climatic treatment he should be firm and decisive in his advice to remain at home. The basis upon which the question should be decided is ability to secure and maintain for an indefinite period the comforts and the dietetic measures which the patient has been able to command at home. Where financial ability to do this does not exist, the patient's limited means can be used to better advantage at home than away. Let such patients change their mode of living somewhat, take the world a little easier, spend a few dollars on extra diet, and in short excursions of a few days or a week from home at frequent intervals, and they will be able in a very great measure to make up what they lose in climate, and it will be at a much lower cost. To some extent it is, after all, the change in mode of life which gives benefit in climatic treatment, and much can be done at home to bring about this change in mode of life.

Great effort has been made by the medical profession to produce climatic treatment of tuberculosis artificially by means of the pneumatic cabinet and by various apparatuses constructed upon the principle of the pneumatic cabinet. To some extent the effort has been successful. Theoretically, at least, every imaginable climate can be produced by the pneumatic cabinet; but the practical application of the climates thus produced has not met with general favor in the profession. This is no doubt due, in a measure, to the cumbersomeness and expensiveness of the pneumatic cabinet and to the trouble involved in the use of smaller and cheaper machines; but it is also in a measure due to lack of confidence in the method and to a feeling that there is something unsanitary in it. The pneumatic cabinet itself is only adaptable to hospitals and sanatoriums, and the fact that these rarely use it speaks against its usefulness. Modifications of the pneumatic cabinet are used in private practice by some excellent specialists, who report good results. The fact that men of ability, who follow strictly professional methods, continue to use the method is a strong argument in favor of its usefulness, and should weigh more in the balance of judgment than the indifference and condemnation of those who have no practical experience with it. Pneumatic cabinets and compressed-air machines are also beginning to be used for direct medication through the respiratory tract with volatile substances. By passing rarefied or compressed air through some volatile substance or by saturating the cabinet with such substance the medicament may be carried into the respiratory tract and deposited on the mucous membrane, to be absorbed by the blood or taken up by the

lymphatic vessels. This opens up a large new field of study which may lead to most valuable results. The ordinary apparatus for the inhalation of oxygen and its various compounds is used for the same purpose.

Dietetic Treatment.—The most important factor operative for recovery in tuberculosis is undoubtedly nutrition. When recovery takes place it does so by way of immunity, and immunity can only be attained and maintained through nutrition. The organism has not only to manufacture force enough for ordinary demands, but it must also make force to fight off the disease which is preying upon it. This force has to be manufactured out of the food which is taken in, and, inasmuch as the force-producing capacity of every organism has its limitation, the shortcomings of the digestive tract have to be made up by the selection of food and by its preparation. Besides, the lungs themselves play an important *rôle* in nutrition, and are under the same nervous government as the other and more important organs of nutrition. When the lungs become diseased the functions of the organs concerned in the nutritive process are apt to be seriously disturbed by reason of the reflex inhibition which is thus set up. Not only is the functional capacity crippled, but the normal instincts for food are disturbed and perverted, so that the individual can no longer safely follow his own cravings in the selection of food, but must follow the calm judgment and wise dictates of science.

As a general proposition, it may be laid down that the diet of the consumptive should give the largest possible amount of nutrition for the smallest possible amount of labor to the organs concerned in nutrition. The two questions upon which every article of diet should be judged are: (1) How much nutrition does it contain? and (2) How much energy will it take to lay up that nutrition in the system? Food which contains very little nutrition, and which ordinarily is used to tickle the palate or gratify a sentiment, should be ruled out of the diet list of a tubercular subject. Food which contains ample nutrition but is difficult of digestion should likewise be ruled out. Food which is easily digested, but which is very bulky, should not be used, because it takes up too much room. In this connection it should be borne in mind that food which does not digest is apt to ferment or decay, and through the poisonous products which it lets loose, to embarrass the entire nutritive process and to incapacitate the digestive apparatus for some time to come. It is therefore not only a question of the loss of the food which has been taken, but a question of the energy that is wasted, of the disturbance that is set up in the entire economy, and of the damage which is done to the force-producing machinery of the organism. For these reasons one single article of diet which has been improperly selected or a single

injudicious meal may do damage which cannot be repaired in a week. A good rule to follow in making out a diet is to give no food which requires more than four hours, at the outside, for digestion in the stomach, and not to give such food at more than two meals a day. Unless such a rule is observed, embarrassment in digestion and evil consequences are sure to come. If, for example, a patient takes breakfast at seven o'clock in the morning and eats food which requires, in a normal state, from four to five hours for digestion; takes dinner at twelve o'clock, and again eats food which requires, in the normal state, from four to five hours for digestion; and at supper again eats food which requires, in a normal state, from four to five hours for digestion: we have, in such a patient, from twelve to fifteen hours' labor for the stomach, under the most favorable circumstances, in a normal state. After each of these meals the stomach is less capable of performing its work than at the preceding one, and with its accumulated incapacity it is apt to pass the last meal into the intestines in a state of fermentation, which even the intestines cannot arrest, and absorption of poisonous products with poisoning of the entire organism instead of sustenance, as intended, is the result. These pernicious consequences may ensue in health when the digestive system is in a perfect condition and unembarrassed by reflex inhibitive influences; in a state of disease, when the digestive system is at best lame, the damage is necessarily much greater. A tubercular subject should habitually take only one, or, at most, two heavy meals a day—that is, meals that require more than four hours for digestion, according to individual capacity. These meals should, moreover, be taken at times in the day when they can be eaten at leisure and be followed by rest and mental recreation. There is no objection to one of the meals being taken in the evening, provided it is taken under favorable conditions and is not too close to the preceding meal. A heavy meal before bedtime will not interfere with sleep when digestion is normal. It is only when the stomach has been overburdened during the day, and is no longer capable of properly performing its labors, that a heavy meal in the evening becomes an impediment to sleep, and then it is not so much the meal as the poisonous products of fermentation, which find their way into the circulation to disturb the brain, that do the mischief. When breakfast and lunch have been light and have properly nourished the organism, and dinner is taken in the evening into a stomach capable of transforming it into nutrition, not only will sleep be undisturbed, but it will also be quiet and refreshing.

As to the kind of foods to be used by tubercular subjects, no hard and fast rules can be laid down. There are some who think that albuminoids and fats ought to predominate, and as a working principle

this idea may well be accepted. Every case must, however, be studied by itself, and the diet must be arranged to suit the idiosyncrasies and tastes of the individual. Some persons cannot take fats at all and do not digest albuminoids well, but can take carbohydrates; while others cannot digest carbohydrates, but can take any quantity of fats and albuminoids. A mixed diet is undoubtedly best, with artificial aid in the digestion of such food as is not well taken and borne. When a food cannot be digested even with artificial aid, and gives rise to disturbance, it had better be omitted, no difference what the theoretical indications for its use may be. Diet should not be mixed too much at the same meal. Carbohydrates and fats may be taken together, and albuminoids and fats may be taken together, but carbohydrates and albuminoids had better be taken separately. A good plan is to make the lighter meals on carbohydrates and fats and the heavier meals on albuminoids. Of the carbohydrates, the best are undoubtedly the cereals; of the fats, cream, butter, and cod-liver oil; and of the albuminoids, milk and meat. Vegetables stand in between the typical carbohydrates and albuminoids and partake of the qualities of both—some shading more in one direction and some in the other. By proper selection some of these may be used at every meal.

Of the articles of diet which deserve special mention as giving the best results with the least labor, milk undoubtedly heads the list. The quantity of milk which can be taken and digested even when other food is taken is remarkable. A person taking one meal a day can learn to drink from four to six quarts of milk during the twenty-four hours, without distress and without overburdening the stomach. In order to be able to take so large a quantity the patient should begin immediately upon arising, or even before getting out of bed in the morning, and continue taking it in small quantities at short intervals during the forenoon. A light breakfast of solid food may be taken some time during the morning, and an ample meal of albuminoids and vegetable foods with a little wine some time in the afternoon. The drinking of milk may be resumed during the afternoon and continued until bedtime. If there is outdoor life, with some exercise, there will be a craving for solid food; and if this is restricted to the breakfast and dinner, it will be eaten with much relish and appetite. The régime here laid down contemplates the taking of from four to six quarts of milk a day, and whilst this quantity seems excessively large it will not be found to be too large in practice with the average individual. Of course, some courage and determination is required on the part of the patient, especially in the beginning; but this courage and determination will be forthcoming if the physician is explicit in his instruction and shows confidence in his own

views. When a smaller quantity of milk is preferred the patient should begin his milk-drinking before rising and continue it at short intervals during the day, taking some at his meals, some between meals, and some at bedtime. In this way from two to three quarts can be taken during the twenty-four hours without interfering with the regular meals. The use of milk soon becomes a habit, and the stomach seems to acquire greater power to digest it as the milk-drinking habit is formed. Most persons develop a fondness for milk after drinking it for a long time, and when they no longer need it really find it a deprivation to try to do without it. There are a few persons who cannot take milk; but of these some can gradually acquire the habit by taking small quantities in the beginning, and little by little increasing the amount. There are a very few who cannot learn to drink it at all. An important matter in connection with the use of milk is the quality of the milk. Milk varies much in digestibility by virtue of its original quality, its age, and the manner in which it has been kept. To be easily digestible it must be: (1) the product of healthy, well-fed cows, (2) not too old, and (3) it must have been properly kept. Not only should the cows producing the milk be free from disease, but they should be free from functional ailments and from physiological disturbances. Milk is more digestible in direct ratio to the shortness of time that has elapsed since its milking. For those who can take it warm from the cow this will be found the most digestible condition to take it in; but for most people it probably will be more agreeable to take when it has been cooled off. If possible, milk should be consumed within twelve hours of milking time, and at farthest within twenty-four hours of such time. In the preservation of milk, cleanliness and sterility are of the first importance. In this connection it must be borne in mind that changes may take place in milk which do not readily manifest themselves, and which cause no reaction to litmus paper, and which nevertheless make it very indigestible. There may even be little in taste and smell, and practically nothing in appearance, to show a change; and yet it may have undergone changes which will give rise to indigestion and set up serious disturbances in the system when taken as food. Such changes are evidently due to some ferment or micro-organism, because a vessel in which such milk has been kept will affect milk which is placed in it until the vessel has been sterilized by a high, dry temperature or by long exposure to the sun. Persons taking large quantities of milk should therefore exercise great care in selecting the source from which they take it, and should themselves take every precaution against contamination during the time it is under their own control. It is only when such precautions are taken that the tubercular subject can get the full benefit of a milk diet, for it is only under

them that he can take the quantity necessary for the best results. When the source from which milk is taken cannot be known the milk should be sterilized. This practice will, moreover, reassure the patient, as at the present time many persons are afraid to use milk because of danger of contracting tuberculosis from it. While such danger may exist theoretically, it amounts to very little in practice; but it may seriously disturb the patient's mind unless he is assured by his physician that there is no danger, and may prevent him from using a most valuable article of diet. Persons who have a natural aversion to milk should be taught to use it, and encouraged in the practice by the physician until they can take it in large quantities; for there is no article of diet which in the long run of the disease will give as good results and weigh as heavily in the scale of chances for recovery.

The next article of diet which deserves special mention is meat. The kinds of meat to be used in the order of their value are, beef, mutton, poultry, and game. Rare, luscious beefsteak is undoubtedly the best form in which meat can be taken. Roasted beef and roasted lamb come next; and well-prepared mutton-chops may be assigned third place. Meat should always be prepared in such a way that the juices are all retained and the albumin is as little coagulated as possible. Meat in some form, of the kinds just mentioned, should be taken by the consumptive in liberal quantities at least once a day. It is better that a very large quantity be taken once a day, than that a small quantity be taken two or three times a day; because the time required for digesting a meat meal is pretty nearly as long when a small quantity is taken as when a large quantity is taken; and whilst the stomach may bear a meat meal once a day very readily, even though the quantity of meat is quite large, it may rebel when this kind of meal is repeated. With persons who can digest a meat meal only once a day, or who cannot digest a meat meal at all, a good plan is to give expressed juice of rare meat at intervals during the day. The way to prepare this juice is to broil a juicy piece of meat, preferably a piece of rump-steak, as this is said to be the juiciest part of the steak, over a hot fire, then cut it in slices and squeeze out the juice either with a lemon-squeezer or a meat-press, which has first been moistened with boiling water. The juice may be flavored with a little salt and pepper, one or both, or with any other flavoring-matter or condiment which may be agreeable to the patient. If it has been allowed to stand and cool off before being offered to the patient, it should be rewarmed by placing it in a vessel and setting the vessel in warm water, and not by placing on a stove, as a high temperature will coagulate the albumin, thus detracting materially from its digestibility. This meat-juice is really a soluble albumin, and is

therefore most nutritious and most easily digested and assimilated. It is the quintessence of food. The juice of several pounds of meat may be given during the twenty-four hours, by giving small quantities at intervals of two or three hours, and the most excellent results will be thus obtained. The only objection to this plan of feeding is the expense, as high-priced meat has to be used, and a large quantity of it has to be consumed in every twenty-four hours; but money expended in this way is well invested, and with people of moderate means much better invested than when placed to the credit side of the ledger accounts of railroads and hotels. Commercial extracts of meat may be used when meat-juice is too expensive for the patient, but there will not be the same results from them, and they must not be substituted for meat-juice when the patient can afford the latter. Beef-teas, of various kinds, as prepared in the old-fashioned way by allowing meat to simmer on the stove for several hours, or by putting it in a bottle with water to extract the nutrition, or by putting it in a skillet and steaming under a cover, are only to be mentioned to be condemned, as they contain very little nutrition, and only delude the patient into a belief that he is getting something which he does not get. Broths of beef, mutton, and chicken are fairly nutritious, and may be taken when the patient has fair digestion and is not easily upset by the grease which is a necessary constituent of such preparations. In cases in which meat-preparations are badly borne by the stomach, some advantage may be gained from the use of the predigested meat-preparations, of which there are a great many in the market. In using these, however, the physician should not permit himself to be misled by the wonderful claims made for them, on commercial grounds. Occasionally a tubercular subject craves some of the coarser meats and meat-preparations, such as pork, veal, sausage, and so on, and upon experiment really finds that he can digest them and feels well on them. For such persons a moderate indulgence in these heavier foods may be allowed, but great care should be exercised lest the privilege be abused, and the digestive apparatus seriously disturbed before the patient is aware that he is doing himself an injury. As a precaution against such a misuse, the physician should give specific directions as to how frequently and when such cravings may be gratified.

Other kinds of albuminous foods which deserve mention are eggs, oysters, and fish. Eggs in particular may prove very serviceable in some cases. They are best given in the raw state, but may also be taken in the cooked state, as suits the taste of the patient. A very agreeable way of taking them raw is whipped up with sugar and milk or sugar and water. They should never be given in the form of egg-nog.

Of the fats, butter and cream come first on the list as best borne by the stomach. Tubercular subjects should be encouraged and exhorted to use butter and cream very liberally in every possible combination that they can think of. Butter should not only be used at table, in the ordinary way, in combination with bread and vegetables, but should be used as freely as possible in cooking. Many dishes can be made more tasty and can be improved in digestibility by preparation with butter. Cream should also be used freely. The milk which is taken should be taken as it comes from the cow with its proper allotment of cream. In addition, cream should be used liberally in the preparation of tasty dishes. It may be used in soups, salads, dressings of various kinds, custards, and in the form which is so agreeable to all individuals, namely, ice-cream. Olive oil and cod-liver oil are the fats which come next in value to butter and cream. Some, indeed, would place cod-liver oil at the head of the list of fats. Many stomachs, however, cannot bear cod-liver oil. Where it can be borne it is undoubtedly one of the most valuable, if not the most valuable fat, at our command, and should be used freely. Its use should be begun on a small scale, say a teaspoonful after meals, and gradually increased until one or two tablespoonfuls can be taken. Sometimes it is well to begin its use in the form of an emulsion until a tolerance for it is established, but when it can be taken in the pure state it had better be taken in that form. Olive oil, whilst possibly less nutritious than cod-liver oil, is much better borne by the average stomach. There are few people, indeed, who cannot take and relish olive oil, particularly in the form of dressings for salads. Some care should be exercised in the purchase of olive oil, as it has many counterfeits in the market. Persons who can use neither olive oil nor cod-liver oil by the stomach may use the one or the other to advantage by inunctions. An ounce or two of either of these oils can be daily taken into the system through the skin if the oil is thoroughly rubbed into the inside of the thighs and into the armpits, where the skin has great absorbing powers. Other fats, such as lard, beef, and mutton-tallow, and the fats of fowls, and even of wild animals, may be used in certain cases, where it is found by experience that they agree better than the fats which ordinarily are well borne. Some of these fats have local reputations among the people for curative powers, and, however much fancy may have had to do with such reputations, they really possess a value as food.

Of the hydrocarbons, sugar and the starches are the staples which enter into the diet of every one in civilized life, and nothing needs to be said about them here, except, perhaps, by way of caution against overindulgence. For some reason or other the tubercular subject is liable to have a craving for hydrocarbons and a loathing for albu-

minoids and fats. Perhaps this craving is an indication of what is needed by the organism in its struggle against the disease, particularly as the greatest waste and destruction is in the fats, which are the product of the hydrocarbons. There is danger, however, in over-indulgence of this craving even though there be a physiological basis for it. Too much sugar and starch may lead to fermentation and absorption of poisonous products, with serious interference with nutrition leading to further devastations of the disease. Hydrocarbons should therefore be used with caution by the tubercular subject, and under the dictates of reason rather than of appetite. An inordinate craving for sweets should not be indulged, and even the starches should be selected from among the leguminous plants rather than the purely starchy edibles. Such vegetables as potatoes and foods made from such products as starch and flour should be used in moderation, whilst greater indulgence should be given in what may be called the grassy vegetables, such as spinach, cauliflower, cabbage, asparagus, squash, beans, pease, and lettuce. In all of these a certain amount of starch is combined with a varying quantity of albumin and in some of them there is a fair quantity of mineral substance, especially iron. In selecting vegetables for the diet of a consumptive it is very important to have variety, frequent changes, and the greatest possible number of methods of preparation. Good cooking plays a most important *rôle* here, for upon the cook more than upon the doctor will depend the amount of vegetable matter which will go into the stomach of the tubercular subject, and be assimilated for his nourishment. One excellent form which the vegetable food of a tubercular subject may take and which well may be served up to him daily is a vegetable puree, prepared from a large variety of vegetables in water and milk. The vegetables should be thoroughly cooked for some hours in water, then milk and condiments should be added and the whole again cooked for a long time; finally the thick, coarse matter should be strained out. This gives a cream-like, tasty soup, rich in nutriment and easily digested.

Fruits of various kinds form an important item in the diet of a tubercular subject. In addition to the albumin and hydrocarbons which they contain they possess acids, which are useful in the maintenance of healthy nutrition. In a measure the selection of the kind of fruit may be left to the patient, provided he use some every day. Oranges are usually preferred by patients because of their acidity, and for the same reason the smaller acid fruits are chosen when they are in season. All of these should be allowed when desired, but some of the more nutritious fruits, such as bananas, ought to be taken at intervals. When bananas are properly ripened and are eaten at exactly the right stage of ripening they constitute a wholesome food.

They are not only easily borne by the stomach, but they also contain a large amount of nutriment. The condition in which they are most tasty and wholesome is that in which the pulp is sufficiently mellow to melt in the mouth and yet shows no evidence of decay. When the pulp has a consistency which gives resistance to the teeth and conveys the impression of being hard or solid, the fruit is not fit for persons of delicate digestive powers. The pineapple is also an excellent fruit, particularly as in some cases it aids digestion.

A valuable and important class of foods which should never be omitted from the diet-list of the consumptive is nuts. In nuts we have a combination of albuminoids and fats, two most desirable nutriments, with a great variety of flavors and conditions in which to serve them and with which to coax the appetite of the patient. They should be partaken of at dinner, and, if the stomach will tolerate more frequent use, at other meals and between meals as well. Probably the most easily digested nuts are the English walnut, the pecan, and the hickory-nut; whilst among those which are richest in oils are cream-nuts, butternuts, black walnuts, and peanuts. Other nuts which are of pleasant flavor and which suit some stomachs well are cocoanuts, hazelnuts, and almonds. When the appetite is capricious and patients cannot take nuts in the raw state, they may be induced to take them in the disguise of caramels and candy preparations, or in cookies, the nuts having been grated or ground into a flour. Some care should, however, be exercised in the use of nuts, not to upset the digestive tract, for there is danger of this, and when it occurs more harm is done than good. As a precaution against injurious effects, frequent change in the kind of nuts and occasional intermission of nut food should be practised.

With persons who are unable to digest solid food of any kind something may be accomplished by a judicious use of the many forms of predigested foods and baby-foods in the market. When such are used they should be frequently alternated, so as to prevent the patient getting tired of them because of sameness. They should be given at short intervals and in such quantities as will not provoke opposition on the part of the patient. In selecting preparations for a given case the likes and dislikes of the patient should be consulted as well as his idiosyncrasies of digestion.

Whilst it is still a mooted question whether or not alcohol is a food, it at least will be in harmony with social customs to consider the use of wines and malt liquors under the heading of dietetic treatment. Placing these articles in the list of foods will, moreover, emphasize the very important difference between the use of alcohol in small quantities and well-diluted forms, and in large quantities and concentrated, highly stimulating forms. Besides, the truth prob-

ably lies, as usual, between the extreme views, and is, that alcohol is a food in certain limited quantities, and becomes a stimulant in amounts beyond those quantities. Then, too, there are other ingredients of malt liquors and wines, solids, diluents, etc., which are of the nature of foods, and which besides their food qualities exercise an influence upon nutrition. There is a wide difference of opinion in the medical profession about the use of alcoholic drinks of any kind in the treatment of tuberculosis. There are men of large experience and of good judgment who unqualifiedly condemn the use of alcohol in any form and quantity, and base their practice upon experience and observation; while there are others, who are apparently in the majority, men of equal experience and good judgment, who use alcohol in varying quantities, from the small amount in wines and malt liquors to the large amount in brandy and whisky—these latter even in large quantities—and claim for their practice the most excellent results. From this diversified practice and these conflicting views it is fair to infer that there yet remains much to be learned about the use of alcohol, both as a food and a stimulant, in the treatment of tuberculosis. The safest practice to follow at present is to use alcohol generally as a food, and exceptionally as a stimulant. Wines and malt liquors may safely be introduced into the diet-list of nearly every tubercular subject. As to whether wines or malt liquors, or both, should be used, will depend upon the previous life of the individual, his temperament, his digestive abilities, and the stage of his disease. When the patient gives a history of having abused the use of alcohol in any form, when he has a nervous, excitable temperament, or when his disease is in the earlier stages and is of rather an acute form, the chances are that he will get along better without alcohol in any form. When the use of alcohol in the form of wine or malt liquors is clearly indicated, the choice between the two, or the question whether both should be used, will have to be determined by the past history, the temperament, the digestive ability, and idiosyncrasies of the patient. Where a person gives a history indicating a gouty or rheumatic diathesis, has a phlegmatic temperament, or shows a need of stimulation of the gastric *rôle* in digestion and nutrition, wine, and preferably the dry wines, should be used; where a person has a nervous temperament, shows defect in the diastasic *rôle* of digestion and nutrition, or cannot tolerate acids very well, malt liquors are indicated; and where temperaments are blended or where the entire digestive department needs stimulation and assistance, both wine and malt liquors may be used alternately or at different times of the day with greatest advantage. In each case much will depend upon the good judgment, skill, and experience of the physician to get the best results.

Dynamical Treatment of Tuberculosis.—There are no factors in the treatment of tuberculosis more potent for good and evil, and yet more generally misunderstood, than rest and exercise. In the popular mind and in the minds of many physicians, including medical writers, there has always been a close association of physical inactivity with consumption. Indoor life, and especially indoor life attended by attitudes which restricted the use of the upper parts of the lungs, have from time immemorial been looked upon as the chief causes of consumption. These accepted views about the relationship between physical inactivity and the disease quite naturally led to physical activity and outdoor life to be looked upon as the most important steps in its cure. Consumption was thus widely separated from other disease in methods of treatment, and was never allowed to interfere with pursuits and occupations which are recognized as requiring physical vigor and health for prosecution. Although, paradoxical enough, the disease was really removed from the category of diseases and placed in that of aberrations from normal methods of living, and the sick man was not looked upon as a sick man until he stood at the brink of the grave and could no longer be rescued from it. These erroneous views upon etiology and treatment mainly have been responsible for the hardships which the average consumptive has to endure, and the sad lack of progress in the treatment of the disease which has been the traditional reproach of the medical profession. Progress in the treatment of a disease cannot be hoped for so long as the full outlines of the disease go unrecognized. While consumption was looked upon as a mere decay or functional aberration, until the stage of its career had been reached from which recovery never took place, true progress in methods of treatment was impossible; but we now recognize the etiology of the disease, and fully understand that the disease begins with the implantation of the tubercle-bacillus in the tissues of the body, and we formulate our treatment upon scientific lines with encouraging signs of progress. Much has already been done, as we have at least brought the treatment of tuberculosis into the same plane with the treatment of other diseases. The tubercular subject is now looked upon as a sick man from the moment the tubercle-bacillus gains admission to his system, and from the beginning his life is regulated with a view to conserve his physical resources so as to enable him to resist the onslaughts of the disease and liberate himself from the hold of the parasite.

As with other diseases so with tuberculosis, rest is now looked upon, not only as a legitimate, but also as an essential measure for cure, but with this difference, that in tuberculosis it is rarely complete rest, but generally comparative rest. The activity of the muscular system is only suspended during very acute stages and in very acute

forms of the disease, and is made use of at other times and in other conditions for the furtherance of nutrition, when this can be done without consuming too much force. Comparative rest and comparative exercise mostly go hand in hand, and when properly scaled to suit the individual case constitute a potent resource for recovery. Absolute rest in the recumbent position is indicated when the tubercular subject has wide excursions of temperature and is losing flesh rapidly, one condition or both. This rest need not necessarily be taken in bed indoors, but may be taken in a reclining-chair out of doors. When feasible and consistent with the comfort of the patient, the rest should always be taken out of doors, and when taken in a room the room should be well ventilated. Rest-treatment can be applied best in a sanatorium, where all conveniences for it exist; but with a little ingenuity and effort it can likewise be applied at home. In city houses to which there is a flat or open porch the patient may take his rest in such places; and where these conveniences do not exist he may take it in a sunny room with the windows wide open. Every precaution must, of course, be taken against undue exposure to cold, and with this end in view the patient should remain in bed or be well wrapped in furs or blankets. Under the absolute rest-treatment, especially when it is taken in the open air, acute symptoms rapidly subside, waste is arrested, and new force with which to meet the ravages of the disease is more speedily created. It is astonishing to what extent the fever lessens, the cough abates, and the appetite improves under such treatment. One of the greatest advantages gained by this method is that the beneficial results are brought about naturally, without the use of drugs, which when used frequently upset the digestion of the patient. As acute symptoms subside absolute rest may be gradually modified, and comparative rest with more or less passive exercise substituted therefor. How long absolute rest should be enforced, and at what time the transition to comparative rest may be instituted, will have to be left in each case to the judgment of the attending physician. As a general principle, it may be stated that the rest-treatment should not be given up too early, and should be resumed if rise of temperature or loss of appetite show itself upon slight exertion. It takes some courage on the part of the physician, and a great deal of tact, to keep a patient quiet for months; but experience shows that this is the correct line of treatment, and that sometimes after three or four months' rest of this kind an apparently hopeless case may recover. The patient may be assured under these circumstances that his hope lies in rest, and that he can lose nothing and may gain something by conserving the force which he has. Sometimes, even in the acute condition, comfort and benefit may be given to the patient by what is called passive exercise—that is, by

the contraction of the muscles through the manipulations of a masseur. Within proper limits, massage may be applied in every case; and as the more acute symptoms subside it becomes of the greatest value as an aid in the distribution of healthy blood and in this way in the nutrition of the body. When the manipulations of a skilled masseur cannot be had, something in this line may be accomplished under the instructions of the physician by the relatives of the patient, who can be taught to rub the patient, and at intervals during the day gently to move the extremities, thus exercising some of the muscles.

When all acute symptoms have passed off, or at least so much of them as reduce the strength and waste the tissues, active exercise may be gradually substituted for passive. Milder forms of active exercise, such as pulmonary gymnastics, short walks, and carriage-drives, may be taken up first. The amount of such exercise should be regulated by the sense of fatigue which ensues. Under no circumstances should excessive fatigue be allowed to occur, for probably nothing will contribute so much to relapse in this disease as fatigue. The best criteria as to whether the amount of exercise which has been prescribed is within proper bounds are the appetite and the weight. If the appetite improves and the weight increases, or at least does not decrease, it may be concluded that the exercise is not excessive and is doing good. Gradually the length of the walks may be increased, pulmonary gymnastics may be supplemented with Indian-club and dumb-bell exercise, horseback exercise may be added to the carriage-drives, and walks up gentle slopes may be indulged in. Not until the circulation becomes entirely normal and all resistance to the flow of blood has disappeared should severe, laborious exercise be introduced. Such a condition can only be reached by slow, gradual progress and after a long period of time. By and by, however, when cough has disappeared, the circulation become normal, flesh been put on, and the ordinary evidences of health been resumed, and it has been found by experience that fatigue and disturbance of the circulation no longer follow ordinary physical exercise, severe outdoor exercise, amounting even to hard labor, may be safely and profitably indulged in. A process of hardening should now begin, during which the single aim should be the building up of strong, healthy tissue and great resisting power to disease. To accomplish such a result will require years of outdoor life, and may necessitate a complete change of avocation. In this connection it should always be borne in mind that a person who has had tuberculosis may retain living tubercle-bacilli in his organism, lying dormant in some out-of-the-way gland or in an encapsulated nodule, even when he is in perfect health, and

that these dormant bacilli may enter the circulation and again start up the disease much later in life if his health at any time should fall to a low enough ebb to make his tissues a good culture-medium for them. For this reason persons who, prior to contracting the disease, led lives conducive to its development, when they have recovered should never again take up the same kind of life. They should, moreover, avoid exposure to the disease as much as possible, because their having had it is an evidence that they have more or less predisposition to it; and while the keen edge of this predisposition may have been dulled by the attack which they have had, it is certain that permanent immunity against the disease has not been established. It cannot be too strongly impressed upon such persons that their future lives will have to be a prolonged vigilance, and a struggle to maintain a high standard of resisting power to the disease, and that they must keep out of harm's way.

Dynamics as a resource in the treatment of tuberculosis should constantly be kept in mind in every case. A judicious activity of the locomotive department of the organism, in the interest of nutrition, with such suspension of it as the exigencies of the case from time to time may require, must tincture the treatment of every case from beginning to end. There is no stage of tuberculosis during which it can be said arbitrarily that rest is the proper thing, or that exercise should be used; but, on the other hand, the one or the other may be indicated in any stage, and they may be indicated alternately at frequent intervals during the progress of the disease. Tuberculosis is not a single attack, but a series of attacks, and for this reason is less likely to follow a typical course than almost any disease with which we have to deal. The acuteness of the disease in the beginning depends in a large measure upon the size of the first deposit and the resisting power of the individual, and the acuteness of subsequent exacerbations depends largely upon the treatment which the patient has received and the resistance to the disease which he has been able to develop. Inasmuch as the dynamic treatment of a case has to be predicated upon the acuteness of the symptoms and the resisting power of the individual, it naturally must be different in every case. With the good old advice in mind not to burn the candle at both ends, the careful physician soon learns to regulate the amount of rest and exercise which will best serve the ends of his patient. Only let him always bear in mind that tuberculosis, from the very first day when the tubercle-bacillus is implanted in the tissues of the body, is a disease of which the chief tendency is to waste tissue, that a great amount of force is necessary to fight the disease, and that the force-producing capacity of every organism is limited, and he will make very few mistakes in his dynamic treatment.

Medicative Treatment.—During the twenty-five centuries for which we have records about tuberculosis and its treatment, many remedies have held reputations as curative agents, but few for a longer period than the lifetime of the man who introduced them. Here and there we find a remedy holding sway for a considerable length of time, disappearing for a while and again reappearing; but as a rule what is found useful in one generation is discarded in the next. But too often we see wonderful cures heralded into the world to raise the cup of hope to the lips of the afflicted, only to be promptly dashed to the ground. This history is not the result of lack of energy and inability. In every age earnest, able men have given thought and study to the subject. Possibly the fault has been in a search for specifics. Little things have been overlooked in the eager hunt for big ones. Particular remedies have been given too great importance in the minds of their discoverers and too little consideration by their fellow-practitioners and by the men who have come after them. Better results would no doubt have been attained if more thought had been given to adjuvants, and less to specifics; and if the little aids which were discovered from time to time had been held fast and correlated in order that each succeeding generation might have been richer in its resources than the preceding one. In every remedy which has ever been used there no doubt has been some virtue, at least, in the hands of the man who knew how to use it, but when measured by the standard of specifics, it necessarily failed. Most men have difficulty in conveying knowledge to others, and for this reason knowledge of when and how to use remedies generally dies with the possessor. There no doubt have been many men in every generation, from the days of Hippocrates down, who have had great skill in the treatment of tuberculosis; but their best knowledge always perished with them. Their skill never became the inheritance of the profession. This to a great degree accounts for the fact that with twenty-five hundred years of experience in the treatment of tuberculosis before us the vast majority of physicians are skeptics about the value of drugs in the treatment of this disease. This skepticism is a stumbling-block in the way of scientific progress. Drugs undoubtedly have a value in the treatment of tuberculosis; but we have yet to learn much about how and when to use them. When we have mastered this part of our task we shall be able to cure many more cases of the disease.

There are four modes of using drugs, all of which are applicable in the treatment of tuberculosis. These are (I) alimentation, (II) respiration, (III) endermatosis, (IV) hypodermatosis.

The method most frequently used is that of *alimentation*. This includes the entrance of drugs into the system through any part of the

alimentary canal from the mouth to the anus. It implies four distinct ways of giving medicine : (1) the administration of soluble drugs upon the tongue, to be absorbed by the vessels of the mouth and pharynx ; (2) the administration of drugs by way of the mouth into the stomach (*A*) for absorption (*α*) in the form in which they have been swallowed, (*β*) after having undergone some chemical change, (*B*) for local action by (*α*) aiding digestion, (*β*) neutralizing or counteracting fermentation ; (3) the administration of drugs by way of the mouth and stomach into the small intestine, to be (*A*) absorbed in the small intestine, (*B*) aid digestion, and (*C*) prevent or counteract fermentation ; (4) the administration of drugs by the rectum into the large intestine, (*A*) to be absorbed by the bowel and (*B*) set up local irritation. Which of the four ways of alimentary administration of a drug is to be used in a given case must be determined by the object aimed at and by the idiosyncrasies of the patient. When local action in the mouth or the upper air-passages is desired, administration upon the tongue for absorption in the mouth should be practised ; when local action in the stomach or speedy absorption into the general circulation is aimed at, administration by way of the mouth for absorption in the stomach should be the method pursued ; when local action in the small intestine or absorption for primary distribution through the lungs is sought for, administration by way of the mouth and stomach into the intestines should be used ; and when local stimulation of the lower bowel or absorption through the abdominal lymphatic system for effect upon the contents of the abdomen or primary action upon the lungs is aimed at, administration by the rectum should be followed. If by reason of functional weakness of any part of the alimentary canal or because of fastidiousness of the patient any of the four ways cannot be used, medication should be practised through the others, and the burden should always be placed where it most easily can be borne. The availability of these four avenues of alimentary administration of drugs is of the greatest importance in the treatment of tuberculosis, and should ever be kept in mind. The short cut to the lungs by way of the lacteals and lymphatics of the intestines through the thoracic duct particularly should be kept prominently in mind. For the purpose of administering by the small intestine drugs should be enclosed in capsules.

Medication by way of the respiratory tract must be assigned second place in frequency of use in the treatment of tuberculosis, although this position by no means represents its relative value. The medical and the lay mind always have been and largely now are dominated by the error that whatever is in the lungs must have gone in by the breath ; hence we need not be surprised to find the average mind captivated with the idea of fighting all diseases of the lungs through the respiratory tract. A moment's reflection upon the

anatomy and physiology of the lungs and upon the etiology of tuberculosis and the biology of the tubercle-bacillus will show the absurdity of such views and give a proper conception of the value of respiratory medication in lung diseases. The lungs are a large sponge, with air-ducts on one side, bloodvessels on the other, and cellular tissue in between. When a tubercular deposit takes place in the lungs the culture usually begins in the cellular tissue, rarely in the air-tubes; and when a nodule has formed there is no communication between the nodule and the air. When the tubercle-bacillus is carried into the system by way of the respiratory tract, as it undoubtedly frequently is, it does not find its way directly into the lung tissue, nor does it usually form a culture in the air-duct, but is taken up by the lymph-vessels and is carried into the bronchial lymphatic glands, where it has to make a struggle for existence, and where, if it survives, it forms its first culture and runs through its first cycle of life. In this mode of entrance, it is only after the bronchial gland has necrosed, and nature attempts to eject the contents of the sac by process of ulceration, that the bacillus finds its way into lung-tissue through the circulation. There is really no time in the whole process of tuberculosis of the lungs, whatever the mode of entrance, when the bacillus can be reached by way of the air-ducts except at the time when it is carried in, before it has been taken up by the lymph-vessels (when it goes in by the respiratory tract) and when it is ready to come out after the ulcerative process has been established. The routes by which the tubercle-bacillus can be reached are the blood-vessels and lymph-ducts, and by these, only before necrosis has set in. It must be plainly seen, therefore, that medication by way of the respiratory tract has a very limited application. It can be used only for such substances as can either be carried into the blood with the air or as may be deposited upon the mucous membrane and be absorbed by the lymphatic vessels. Remedies which can assume the form of gases may find their way into the blood through the respiratory tract, and substances which can be broken up into very fine particles by a spray may be carried far enough down the bronchial tubes to be taken up by the bronchial and lymphatic system and carried into the bronchial lymphatic glands. With only such is it worth while making effort to treat tuberculosis by the respiratory tract.

Medication by the endermic method has been used from time immemorial, but has never received the recognition which it deserves. Its neglect has no doubt been due to the apparent irrelevancy between the skin and the lungs. But here again anatomy and physiology, together with the etiology and pathology of tuberculosis, will help us to arrive at the truth. The skin is in a sense the largest and the most important organ of the body, and through the myriads of

lymphatic vessels which permeate it everywhere offers a ready entrance to the circulation. It is not a direct, quick way of getting into the circulation, but it is an even way, and furnishes a permanency and constancy of medication which no other route supplies. Now from the very nature of tuberculosis we need an even, constant, continuous medication by which the influence of a medicament may be unintermittingly kept up for a very long period of time. All of this is furnished us by the endermic method. The endermic method of medication may be applied: (1) by inunctions, (2) by vesication, (3) by pustulation, (4) by topical applications, (5) by baths. Inunctions may be practised with such substances as will dissolve in oil or any fatty substance. The medicament is thoroughly rubbed into the meshes of the skin, where it will be gradually taken up by the lymphatic vessels and carried into the circulation. Vesication gives a more speedy method of getting into the circulation, but for this reason one of more restricted applicability. It may be practised: (*a*) for the purposes of drawing the serum from a certain part to be reabsorbed or (*b*) for the purpose of making a raw surface upon which a drug may be placed for absorption into the blood. Pustulation is a slow method of setting up local leucocytosis and opening up an avenue, by way of the lymphatic system, for substances which we desire to get into the blood. Topical applications give entrance into the organism through the lymphatic system, but are available only for medicaments which can be easily taken up by the skin. Baths as a means of introducing medicaments into the system are of limited applicability, because the absorbing power of the skin is slow when the medicament is dissolved in water. In these various forms of endermic medication we have a method which is particularly well adapted to the treatment of tuberculosis, because of the slow and insidious nature of the disease and the constant prolonged medication which is necessary.

The hypodermic method of medication is somewhat similar to the endermic method, but differs from it in speed of action. When a substance is thrown under the skin it finds its way into the circulation both directly through the bloodvessels and indirectly through the lymphatic vessels. It is really the most rapid method of medication at our command, with the exception of direct entrance into the blood through the veins and arteries. The hypodermic method may be divided into (*a*) the subdermal, (*b*) the intramuscular, and (*c*) the intraseral. The subdermal carries the medicament into the cellular tissue underneath the skin, where it is slowly taken up by the bloodvessels and lymphatic vessels; the intramuscular carries it into the deeper tissues, where, owing to greater pressure, it is more rapidly taken up, probably largely through the bloodvessels; the intraseral

places it in serous cavities, to be absorbed by the lymphatic vessels, where, owing to the large number of such vessels and their activity, it may be very speedily or slowly taken up according to the size of the cavity. The hypodermic method, like the endermic method, is well adapted to the treatment of tuberculosis, because it furnishes a direct and speedy route to the seat of trouble. It is much more rapid than the endermic, and also much more direct, and for this reason is preferable to it in certain conditions where speedy action is needed, such as, for example, in the early stages, where the entire process might be cut short by a little timely assistance; but it is inferior to the endermic method in the chronic condition where the disease is well established and where long slow medication is necessary.

There is probably no disease with which the physician has to deal in the treatment of which methods of medication play a more important *rôle* than in tuberculosis. This is so because, in dealing with this disease, not only are many resources necessary for the many diversified conditions which may arise, but in every individual case new combinations of physiological disturbances, pathological conditions, and psychological peculiarities may exist. No treatment ever fits two cases, so that to be successful one must be able to adapt methods to every case that presents itself. In proportion as the physician is able to do this will he be successful in dealing with tuberculosis.

The use of drugs in the treatment of tuberculosis may be predicated upon (1) the predisposition, the resisting power, and the eccentricities of the patient; (2) the tubercle-bacillus; (3) disease-germs which set up mixed infection or run parallel courses with the tubercle-bacillus.

The predisposition, the resisting power, and the eccentricities of the person suffering from tuberculosis must be carefully studied in every case, and will at the outset give a fair indication of the results which may be attained. Where there is a strong natural predisposition, a weak resisting power, and a purposeless, resistless disposition to drift where the strongest force may carry, recovery can scarcely be hoped for; whilst where there is a weak predisposition, and strong resisting power, and a firm obstinate determination to recover, recovery is not only possible but very probable. Whatever lessens predisposition and increases resisting power makes for recovery. To a great extent both of these objects are attained by the same measures. The only exception to this rule is in family and racial predisposition, both of which may be possessed concomitantly with perfect health. Where family and racial predisposition exist the disease is apt to run a rapidly fatal course in spite of all that can be done. Every effort,

however, should be made to break the force of the disease and to guard against autoinoculation, in order that if the first attack subsides recrudescence may not be provoked. The only hope in such cases lies in keeping the amount of disease-producing matter, which enters the system, as low as possible, and in making every effort possible to establish artificial immunity. Individual predisposition, whether inherited or acquired, offers a less serious impediment to recovery. The weakness of constitution and the deformity which come from faulty life of the parent or of the individual himself may, to some extent, be overcome by better environments and mode of life, and by persistent effort at strengthening weakened parts. Whatever is wrong from such causes can usually easily be detected, and can therefore be remedied to some extent.

For the establishment of resisting power as a measure for recovery in tuberculosis we have to depend largely upon food, fresh air, and everything that goes to make up healthy living; but we also have resources in drugs. In prescribing drugs we should always keep before us the rule to give nothing which may irritate or interfere with an organ, but always to follow nature as closely as possible, and when symptoms indicate an effort on the part of nature to throw off the disease, to be extremely guarded about interference. We should give only such drugs as help along nature's effort, and only give them when it is quite evident that aid is needed. In this connection it should always be kept prominently in mind that reflex disturbances may seriously mislead on the one hand, and interfere with important functions on the other. Owing to the distribution of the pneumogastric nerve, for instance, we may have marked symptoms of lung trouble, such as irritable cough and pain in the chest, due to an overburdened stomach; and we may have serious functional interference with the stomach due to a comparatively small deposit in the lungs. Again we may have marked disturbances in the larynx, as manifested by huskiness of voice, due to tubercular involvement of the bronchial glands; or we may have functional disturbance of the heart and the entire circulatory system, due to a trifling deposit in the lungs because of impediment to the lesser circulation. All of these reflex and secondary disturbances necessitate great circumspection in the use of drugs, because one can so easily be led to treat what seems to be a harassing symptom from the wrong end. What is more natural than to give an opiate for a cough, apply local treatment to the larynx or throat for hoarseness, and give depressants for increased heart action, and yet in doing these things one may not only waste time and energy, but also do positive injury by further embarrassing organs which needed to be relieved and helped rather than irritated and embarrassed. When there is a

slight tubercular deposit in the lungs, enough reflex disturbance of the stomach may be set up thereby to embarrass it in the performance of its duties, and indigestion is much more apt to occur than in the normal state. The indigestion thus set up produces in its turn a reflex disturbance in the lungs, which, in addition to that already set up by the tubercular deposit, is liable to give rise to a very irritable and annoying cough. To relieve such a cough with an opiate or a depressant is apt further to embarrass the stomach in its work and to prepare the system for new inroads of the disease. The rational treatment of cough under such circumstances is not from the end of the lungs, but from the end of the stomach, by giving aid to digestion and thus removing the stomach-reflex. The regulation of the diet and the free administration of pepsin and hydrochloric acid will not only give much quicker relief than an opiate, in these cases, but will materially advance progress toward recovery. For the same reason it is useless to make local applications to the larynx and pharynx when the tubercular deposit is in the bronchial glands, because the irritated nerves thus only will be further disturbed, and may react as a stimulant upon the progress of the disease in the glands. Inhalation of substances which can be carried well down into the bronchial tubes to be taken up by the lymphatic vessels, topical applications over the chest and between the shoulder-blades, and administration of sedatives in sufficient quantity to allay excessive irritation, will give better results. So likewise in regard to the circulation: injury may be done without giving relief by trying to depress the action of the heart. The proper thing to do is to remove the obstruction to the circulation, by absorbing as rapidly as possible the tubercular deposit, by withdrawing blood from the congested lung with counter-irritants, and by relieving the entire system of secondary embarrassments, such as may come from indigestion, overwork, excitement, worriment, and disturbance of excretory organs. The moment the labor of the heart is reduced to an amount within its normal capacity, heart action will become normal and the circulation will be restored to its natural condition.

We have in our armamentarium for the treatment of tuberculosis many drugs which can be used for building-up purposes [1] all of which have given good results in the hands of competent men who have known how to use them. The great difficulty lies with the indication for their use. It is because some men understand indications, and are able to use drugs just at the right time and in the right place, whilst others are not, that we have such a difference of opinion from honest

[1] For information upon the action of therapeutic agents mentioned in this article, the author relies upon personal experience, current literature, U. S. Dispensatory, and Merck's Index.

careful observers upon the value of drugs. With more exact observations and better knowledge of the etiology of disease we may hope to have recorded more positive and exact indications for the use of drugs. The drugs which have been used with good results for building up resisting power are, strychnine, digitalis, animal and vegetable digestive ferments, the hypophosphites, phosphorus and its preparations, calcium and its preparations, sodium and its preparations, iron and its preparations, potassium and its preparations, bismuth and its preparations, a few magnesia compounds, charcoal, nitroglycerin, mineral and fruit acids, vegetable tonics and diffusible stimulants.

Strychnine seems to have been unanimously accorded first place. How it acts has never been satisfactorily explained, but it is generally conceded that it stops waste and helps to build up nutrition. It may be that it acts by overcoming in some way the inhibition which the irritated nerve-ends of the pneumogastric nerve in the lungs exercise upon nutrition. But whatever its mode of action, we have ample clinical evidence to show that under its administration emaciation ceases and weight is put on. Of course, this is not true in every case, but only as a general proposition. Use of the drug is indicated in the early stages of tuberculosis and in the more chronic stages when the activity of the disease has subsided. It is apparently contraindicated during the very acute stage of the disease, during the stage of necrosis which immediately precedes ulceration and evacuation, and when there is marked mixed infection. These indications and contraindications must, however, be accepted only in a general way, for as yet we are not able to lay down fixed rules. The safest plan is to begin with comparatively small doses, say $\frac{1}{60}$ of a grain, in cases in which there is a general indication for its use; gradually increase the dose, so long as good results follow, until the point of tolerance has been established; maintain the dose of tolerance while improvement continues; again go back to a smaller dose, when it ceases, for a new cycle of increase, but stop the use of the drug the moment it becomes evident that it is not well borne or that it no longer can be used to advantage. Some observers claim that the best results are obtained when the drug is given hypodermically; but in private practice it is impracticable to administer it in this way. The preparations of strychnine which are most frequently used are the sulphate and the phosphate. The phosphate is apparently better borne by the stomach than the sulphate.

Digitalis was at one time looked upon as a specific in tuberculosis, and had as sponsors for its claim some of the most distinguished physicians of the beginning of the nineteenth century. It did not maintain its reputation, probably because clear indications for its use were not discerned, and, being used indiscriminately, gave rise to

disappointments. It undoubtedly has value in well-selected cases, and its availability is well worthy of more general consideration. Incompetence in the circulatory system, whether in the bloodvessels or the heart, constitutes the indication for its use. Contraindications are overacting heart and constricted bloodvessels. Clinically the impulse and the sounds of the heart are the proper guides by which to determine for or against its use; when there is a soft, lax, liquid pulse, a weak, timid impulse or a flabby, murmurish heart-sound, digitalis should be used; when there is valvular disease with incomplete compensation it should likewise be used; but when there is a quick, thready pulse, an exaggerated impulse, or a high-tensioned heart-sound it should not be used. Where the use of digitalis is indicated the drug should be administered in well-sustained doses so long as its beneficial influence is manifested.

Animal and vegetable digestive ferments are among the best weapons at our command for dealing with tuberculosis. This is so because malnutrition constitutes good soil for the tubercle-bacillus, and where malnutrition exists natural digestive ferments invariably are either defective or deficient. Diastase, pepsin, caroid, and pancreatin are indicated, therefore, in some stage or other of nearly every case of tuberculosis. When starchy food is not properly digested diastase in some form should be used before or during meals. Up to the present time the only available diastase is that which is furnished us in the various malts, and as a great many of the malts in the market contain no diastase, care should be exercised in selecting one. It is unwise to permit the patient to select his malt, because he will invariably be influenced by other considerations than the quantity of diastase which the malt may contain. The clinical indication for the use of diastase is gastric fermentation, as shown by gaseous eructations after taking starchy food. Pepsin and caroid are indicated when the stomach shows incapacity for the digestion of albuminous food, and should be given after meals. Choice between pepsin and caroid can be made best empirically as the physician gains knowledge of his patient. As a rule, pepsin will be found the more efficient. The clinical indications for pepsin and caroid are: labored or incomplete digestion, as shown by dry, irritable cough, heavy, languid feeling after eating, slightly coated tongue, subnormal in moisture, want of appetite, and dislike of food. Pancreatin is likewise an excellent digestive ferment, and can often be used with great advantage to supplement the use of pepsin. It gives the best results when administered some hours after meals. The clinical indication for its use is intestinal fermentation, as shown by distended bowels and a feeling of discomfort in the abdomen. Frequently pepsin and pancreatin are given together, and whilst this practice gives good results,

better results can be obtained from the administration of the two preparations separately, the one immediately after meals and the other some hours after meals. Pepsin acts best in combination with hydrochloric acid, and pancreatin in either a neutral or alkaline menstruum, which is an additional reason for the separate administration of the two preparations.

The hypophosphites have been a favorite remedy in tuberculosis from time immemorial, and whilst they do not possess the virtues ascribed to them by persons interested in them commercially, they are undoubtedly an adjuvant worthy of the consideration of the therapeutist. Just in what way they act is not known, but the probabilities are that their value lies in their power of supplying certain constituents of the body which ordinarily have to be taken out of food. The hypophosphites which have been used at one time or another in the treatment of tuberculosis are: the hypophosphite of calcium, the hypophosphite of potassium, the hypophosphite of magnesium, the hypophosphite of iron, the hypophosphite of strychnia, and the hypophosphite of sodium. A favorite prescription has been a syrup of these various hypophosphites, under the name of the compound syrup of the hypophosphites. This prescription takes in all which under modern methods is no longer a recommendation. Better results will be obtained when more exact knowledge is at hand and single preparations are adapted to individual cases.

Phosphorus and its preparations, other than the hypophosphites, likewise have held a well-sustained reputation as curative agents in tuberculosis, and their usefulness is no doubt based upon the same fundamental law as that of the hypophosphites. Phosphorus is a constituent of nerve-tissue, and the nervous system, from the brain to the smallest nerve fibre, play a minor *rôle* in the symptomatology, if not in the pathology, of tuberculosis. Some observers look upon the nervous system as the storm-centre of tuberculosis, and upon changes in other parts as mere consequences. Science, however, no longer admits of such post-consequential conclusions; there is no longer even ground for debate as to whether the changes in the nervous system are cause or effect. That pathological changes take place and exercise an untoward influence in the progress of the disease cannot be doubted; but they are in line with disturbed nutrition, and therein may lie the explanation of the value of phosphorus and its preparations. Preparations of phosphorus which, in addition to phosphorus itself and the hypophosphites, have been used in the treatment of tuberculosis are: the phosphate of guaiacol, the phosphate of strychnia, the phosphate of strontium, the dibasic phosphate of potassium, the phosphate of copper, the phosphate of iron, the lactophosphate of calcium, the lactophosphate of calcium and iron, the

glycerinophosphate of calcium, the chlor-hydrophosphate of calcium-creasote, the phosphosalicylate of bismuth and sodium, the lactophosphate of manganese, the dilute orthophosphoric acid, the compound syrup of the phosphates, and dilute phosphoric acid. All of these preparations have at one time or another been used in some form of tuberculosis; but with most of them the only legacy which comes to the profession is a vague knowledge that they have a value of unknown quantity. They are commendable weapons which the physician's ingenuity and observation may turn to advantage. There is something in knowing that they have been found useful, even though the exact method in which they have been used is unknown. The general principle that they are useful for building-up purposes may be made the starting-point for further and more exact observations.

The calcium preparations which have been found useful in tuberculosis are: calcium benzoate, calcium hippurate, calcium hypophosphite, calcium iodide, calcium lactate, calcium and iron lactophosphate, creasote-calcium chlor-hydrophosphate, calcium chlor-hydrophosphate, calcium carbonate, and calcium chloride. It is evident that in all of these preparations both the base and the combining element may contribute to the usefulness of the drug; but the calcium itself seems to be of chief importance. Theories have been advanced about the action of calcium as a curative agent in tuberculosis upon the antithesis which seems to exist between a gouty diathesis and tuberculosis; but we have neither clinical nor experimental substantiation of them. Unfortunately, also, we have as yet no definite indications for the use of either the calcium salts in general or for any one preparation in particular. All that can be said about them is that they are indicated for the purpose of building up resisting power. The history of the patient, his temperament and idiosyncrasies, and the stage of his disease will probably give the best clue for the selection of the particular preparation.

Of the sodium salts, the following have at one time or another been used in the treatment of tuberculosis: sodium benzoate, sodium bromide, sodium cantharidate, sodium citrate, sodium chloride, sodium formate, sodium hypophosphite, sodium iodide, sodium sulphocarbolate, sodium tellurate, and sodium arsenate. The majority of these preparations probably owe their virtue more to the combining element than to the base. Sodium chloride has been used chiefly as a hæmostatic. Yet sodium is an important constituent of the body, and may be a more important remedy for building up resisting power to disease than is generally recognized. Farmers look upon sodium chloride as a most valuable resource for keeping their cattle in a sleek, healthy condition.

Of the iron preparations, there have been used in tuberculosis: reduced iron, iron arsenate, iron bromide (ferric and ferrous), iron hypophosphite, iron iodide, iron sulphate, iron and quinine chloride (ferrous and ferric), calcium and iron lactophosphate, quinine ferrocyanide, potassium ferrocyanide, iron citro-iodide, and iron phosphate. As with the sodium salts so with the iron salts, the virtue in many of them lies as much in the combining element as in the base. Like sodium, iron is also an important constituent of the body, and for this reason has value of its own for building-up purposes. Iron sulphate, quinine ferrocyanide, and potassium ferrocyanide have been used principally for night-sweats. The clinical indications for the use of iron are: pale lips, pale hands, and pallor in general, or any evidence of decrease or decay in red blood-corpuscles. In the use of iron care should be exercised not to interfere with digestion nor to disturb assimilation. The dose must be made suitable to the individual, and in some cases it is well, as a further precaution, to give the iron in combination with pepsin. There are many agreeable preparations of iron which are commonly prescribed, such as syrup of the iodide of iron, elixir of quinine, iron, and strychnia, and various formulary preparations, some of which may be found suitable in certain cases, but as a general proposition it is better for the physician to select his preparation of iron for its adaptability to the case in hand.

Of the potassium salts, there have been used in tuberculosis: potassium cyanide, potassium ferrocyanide, potassium hypophosphite, potassium iodide, potassium phosphate (dibasic), potassium sozoiodolate, potassium sulpho-cyanate, potassium tellurate, aluminum et potassium sulphate, potassium guaiacolsulphonate (thiocol), sulphurated potassa, potassium antimonate, potassium camphorate, and potassium bromide. All of these preparations have found favor with competent observers either in the general treatment or for particular symptoms. The one which has been most frequently used is the hypophosphite of potassium, which enters into the make-up of the compound syrup of the hypophosphites. Some of the preparations evidently owe their virtue to the combining element. Potassium preparations have not found much favor with the profession at large, probably because they are somewhat severe on the digestive system. Potassium to a small degree enters into the make-up of the body, and it may be that if we better understood the use of the potassium salts we would find in them a valuable resource for the building up of the system against the onslaughts of tuberculosis.

The magnesia compounds which have been found useful in tuberculosis are magnesia benzoate and magnesia gynocardate. In both the value probably lies in the combining element.

In bismuth and its preparations we have a remedy for tuberculosis which is valuable more on account of its local effect than of its constitutional influence. Preparations of bismuth which have been used are bismuth subnitrate, bismuth nitrate, bismuth salicylate, bismuth and sodium phosphosalicylate. Bismuth preparations are indicated when there is an irritated condition of the digestive tract, as shown by a dry, furred tongue and small, semi-liquid, rather frequent stools. They can usually be combined advantageously with pepsin, pancreatin, charcoal, and chalk.

Charcoal, like bismuth, is valuable in the treatment of tuberculosis on account of its local action upon the digestive tract. It is a good oxidizer, and is one of our best remedies for the prevention of fermentation. It is indicated in all forms of indigestion which are accompanied by fermentation, and particularly in that form which the people so graphically term "windy dyspepsia."

Nitroglycerin is a remedy of great value in the treatment of tuberculosis. It is probably our best remedy in that demoralizing symptom, or accident, hæmoptysis, when it occurs during the early stages of tuberculosis. Nothing so discourages the patient and his family as hemorrhage, particularly as it frequently comes on when the patient has been doing unusually well, when he has been eating well, has been gaining weight, and when the road to recovery has looked smooth. The fears and discouragement of the patient often demoralize the physician and make him resort to heroic measures to check the hemorrhage, thus upsetting the digestive system of his patient, and by locking up decomposing blood in the bronchial tubes bringing about secondary complications which, when the patient has survived them, leave him in a much worse condition than he was before the hemorrhage occurred. In nitroglycerin we have a remedy which in the majority of instances obviates this harsh, irritating treatment. Hæmoptysis, as a rule, is due to constriction of the bloodvessels and overaction of the heart, and nitroglycerin acts by relieving the constriction and resting the heart. For this purpose the drug should be given in about $\frac{1}{400}$-grain doses every hour and gradually increased to toleration. Aside from its use in hæmoptysis, nitroglycerin will be found a valuable remedy in all conditions in which there is overaction of the heart or embarrassment of the kidneys due to constriction of the bloodvessels. Other hæmostatics which have been used are: opium, ergot, tannic acid, gallic acid, aconite, potassium antimonate, sodium chloride, iron and quinine chloride, ipecac, hamamelin, lycopin, digitalis, and veratrum viride. Opium, aconite, veratrum viride, and ipecac act on much the same principle as nitroglycerin, by relieving constriction. The astringents, ergot and digitalis, act by constricting the bloodvessels and

making the blood more coagulable, and for this reason should only be used in the advanced stage of tuberculosis, when the hemorrhage is more likely to have taken place from a bloodvessel of some size.

Mineral and fruit acids are valuable resources in the treatment of tuberculosis by reason of their action upon digestion and nutrition. Dilute hydrochloric acid should almost invariably be used along with pepsin when the latter is prescribed, as it greatly enhances its value. Dilute phosphoric acid, dilute nitromuriatic acid, and dilute sulphuric acid may also be used advantageously in selected cases. Fruit acids are best given in fresh fruit, of which tubercular subjects should partake liberally at all times.

Vegetable tonics are of service in every stage of tuberculosis for stimulating appetite. Cinchona, cardamom, gentian, columba, and quassia are those which are most commonly used for this purpose; but goldthread, yellow root, chamomile, thoroughwort, yarrow, dogwood, and wild cherry may be found serviceable in certain cases. Cinchona and gentian may be used in the form of elixirs; the others must be used in the form of tinctures, extracts, or infusions.

Diffusible stimulants are legitimate therapeutic agents in the treatment of tuberculosis. The forms in which they are most available are: the stronger alcoholic preparations and aromatic spirit of ammonia. Alcohol occupies a dual position in the treatment of tuberculosis: as an article of diet and as a therapeutic agent. As therapeutic agents, the diffusible stimulants should be used with exactness. The old-time idea that consumptives need stimulants and cannot use them too freely, should be discountenanced by the medical profession. It should ever be kept in mind that stimulants may do injury as well as good. As commonly used, they in all probability do more harm than good. A good rule to follow is to use them only when there is a positive indication for them, and to stop using them when the indication has passed away. The principal indications for their use are a depression of the nervous system, as manifested by feelings of melancholy and a disposition to fret and worry, and the existence of mixed infection, especially of those forms leading to catarrhal inflammations of the bronchial mucous membrane. Some observers claim that high temperature is an indication for their use. As high temperature is usually produced by pus-producing germs or the pneumococcus, this claim is probably well founded. Much, however, remains to be learned about the whole subject of stimulation in tuberculosis. With our present knowledge conservatism is the safest policy. As to a choice between aromatic spirit of ammonia and the stronger alcoholic preparations, such as brandy and whiskey, much depends upon the past history of the patient. When alcohol has been used habitually, aromatic spirit of ammonia will probably give

the best results; but when the patient has been unaccustomed to the use of alcohol the alcoholic stimulants should be given the preference. Sometimes it will be found to be of advantage to combine the two. When aromatic spirit of ammonia is used it should be given in large doses, from ½ to 1 drachm at a dose.

Medication in tuberculosis, as predicated upon the tubercle-bacillus, may, theoretically at least, have two objects in view: direct attack, with a view of destroying the bacillus; and indirect attack, with a view of destroying the soil upon which the bacillus grows. Direct attack is what may be called germicidal treatment, and indirect attack what may be called immunizing treatment.

Germicidal treatment, up to the present stage of medical science, holds out little hope. From the very nature of tuberculosis it is impracticable with the germicides at our command. During the greater part of the tubercular process the bacilli are shielded against attack by being entombed in necrosed tissue. The only times when they can be reached directly are when they are carried in the circulation before colonization takes place, during the early stages of colonization before necrosis sets in, and after necrosis, when they return to the circulation, to begin a new cycle of life. During the time that they are carried in the circulation before colonization, and during the early stages of colonization, before necrosis, the clinical symptoms are so meagre that patients seldom consult a physician, and when the bacilli return to the circulation, after necrosis, they are apt to do so gradually and for a long period of time, when it cannot be known from clinical symptoms. It would be therefore practically impossible to attack them in the blood and living tissues even if we had the remedy with which to accomplish it. But we have no such remedy at present, for the germicides which destroy the tubercle-bacillus also destroy the living tissues of the body. It may be that at some future time a remedy will be discovered which can be kept freely circulating in the blood for an indefinite period, in sufficient strength to kill the tubercle-bacillus, without doing damage to the living tissues; but so far no such remedy has been discovered. For the present our hope lies in the indirect method of attack, by destruction of soil, or, in other words, by the creation of immunity. If we can successfully destroy the soil, it will make no difference how many bacilli may be poured into the blood nor for how long a time they may circulate in it, as they cannot again get a foothold; and in the course of nature the time will come when the last one will have died or have been ejected from the economy. For the present this constitutes our only method of cure.

As therapeutic agents for the establishment of immunity we have at our command the nucleins, the serums, and a limited number of

drugs. A great deal of research is going on at present along the line of such preparations, and, if the future may be foretold by the past, with prospects of gratifying results.

The nuclein treatment of tuberculosis is based upon the idea that the soil for the tubercle-bacillus can be destroyed by introduction into the blood and tissues of certain products of fermentation, obtained from animal life and plant life in other departments of nature. The theory is rational enough, and is in harmony with our general knowledge of biology, and particularly with that branch of it which has to do with the production of poisons. Really, many of the remedies, which we take from the vegetable kingdom and some which we take from the animal kingdom owe their existence to that fundamental law according to which plants and animals have the power of producing in their cell action substances which destroy life in other animate objects. The nuclein treatment of tuberculosis has not yet been fully developed, and it is too early to say what will finally come of it; but besides being based upon a rational theory, there is to be said in its favor that excellent reports have been made upon it by men who know most about it and who have given it long trial. Such men report a large percentage of recoveries. It is proper to make some allowance for enthusiasm in these reports, but nevertheless it is only fair to accept the conclusions embodied in them in preference to adverse conclusions based upon more limited experience. Except that the nucleins should be used in the early stages of the disease, so far we have been given no definite indications for their use.

The serums owe their existence to the same fundamental law which has given us the nucleins, only upon a somewhat different application of it. It has long since been known that all living organisms possess the power of gradually acquiring immunity to the poisonous products produced by other living organisms. Indeed, it is in accordance with this fundamental law that organic life is able to maintain its existence upon earth. How the law works out in detail, whether by removing something from the system or by adding something to it, we do not yet know. Whatever the method, however, tolerance is established and the poisonous effect upon life is removed. In the serum-treatment of tuberculosis the object is to introduce something into the blood which will deprave or neutralize the soil, and thus destroy the bacilli or prevent further development of colonies. For this purpose two methods are practised: 1. The introduction of a substance into the circulation which has been extracted from the tubercle-bacillus, artificially grown in an abnormal culture-medium, and which has the power of poisoning, so to speak, the bacilli and bringing the tubercular process to a speedy

termination. This substance is called tuberculin, and more recent modifications of it, tuberculocidin and tuberculin-R. 2. The introduction of a substance into the circulation out of which the pabulum upon which the tubercle-bacillus feeds has been consumed. This is called antituberculin. For the production of antituberculin a large animal with good natural resisting power, preferably the horse, is inoculated with gradually increasing doses of tubercle-bacilli until he develops a resisting power to a maximum dose, when his blood is drawn off, and the serum, after having been duly aged, is used as an immunizing agent for human beings. This latter is really the true serum. The other, although ostensibly an extract, is a serum in the broad sense of the word, for both preparations are based upon the same fundamental law and differ only in the culture-medium used for their preparation. Much has been written about the value of the different serums in the treatment of tuberculosis, and such variant opinions have been given that it is difficult to arrive at a just conclusion about them. As with the nucleins, so with the serums, some allowance must be made for the enthusiasm of discoverers and the optimism of men who follow certain lines of treatment; but with due consideration for experience and qualification to speak, the consensus of opinion seems to be in favor of their usefulness. The indication for the use of both forms of serum seems to be that they be used in the early stages of the disease. Some prejudice has sprung up against these preparations because of injurious results which were reported to have followed their use when the treatment first came into vogue. Since then the serums have been much improved in quality, and the objections which justly lay against their use in the beginning do not seem any longer to exist. The only objection which still holds is the cost, which is so high that in the average case of tuberculosis it is prohibitive.

In line with the serum-treatment of tuberculosis, and based in all probability upon the same fundamental law, is the old-time treatment with counterirritants by means of dry-cups, irritating plasters, fly-blisters, and setons. There never has been in general use any treatment which has held its reputation more evenly and for a longer period of time than this. It was in use in the days of Hippocrates and is used to-day. The mode of action has never been understood, although it has generally been believed that the benefit derived from the treatment was due to the drawing away of blood from the seat of disease. In the light of the germ-theory of disease this explanation no longer suffices, and a more rational explanation is at hand. Withdrawal of blood may account for some of the benefit upon the score of starving out the germs at the seat of disease; but this would not explain all. It is more probable that the injury done to the surface by dry-cups, plasters, fly-blisters, or setons sets up a

leucocytosis which may exercise a phagocytic influence upon the disease and separate from the blood ingredients which are reabsorbed and create unfavorable soil for the germs. But whatever the explanation, it is clinically certain that the pouring out of serum into a cavity or into an artificial reservoir such as is created by a fly-blister, and its reabsorption into the blood, and the formation of pustules under an irritating plaster, and the opening of a sinus with absorption of the liquid portion of the broken-down tissue, have strong curative tendencies. Indeed, absolute recovery after absorption of a large quantity of serum from a tubercular joint, from the peritoneal cavity in abdominal tuberculosis, and from the pleura in tubercular pleurisy, is not an infrequent occurrence; and the chronicity of tuberculosis when it is accompanied by running sores is traditional. The fathers of medicine, from Hippocrates down, frequently cured tuberculosis by the establishment of large setons in remote parts of the body, keeping them open for months and years; and as far as we can judge at the present day this constituted their best remedy. In the use of fly-blisters great care should be exercised to have all the serum returned into the circulation by absorption. In order that this may be accomplished, the fly-blister should not be allowed to remain in place longer than an hour or two at the outside, and for the purpose of drawing out the serum a hot fomentation should be placed over the reddened surface when the plaster has been removed. In this way the epidermis will retain sufficient cohesive power to hold the serum in the reservoir until it can be absorbed, which will take about twenty-four hours.

Of the drugs which tend to set up artificial immunity in tuberculosis the most valuable is undoubtedly iodine. The literature on tuberculosis during the last half century at least is dotted over with evidence of the curative powers of this drug. Many and many a time has the drug been taken up by some investigator or observing clinician, and good results reported on its use, but invariably the seed of truth fell upon barren soil so far as the general profession was concerned. The chief impediment to general recognition by the profession of the value of the drug was no doubt due to its tendency to disturb the digestive system when given in large doses. Moreover, there was some difficulty about selecting preparations of the drug. Different preparations found favor with different clinicians accordingly as each discovered methods of using them without deranging digestion; but the trick of doing this never became public property, and therefore no particular preparation found favor with many. In recent years new iodine preparations have been introduced, many of which possess the ideal qualities for use in the treatment of tuberculosis. New methods of using them which can in no way interfere with

digestion have also been suggested, so that there no longer exists good reason why any practitioner of medicine should fail to avail himself of the use of this drug. The preparations of iodine which have been used at one time or another in the treatment of tuberculosis, and from which selections may be made to meet any idiosyncrasies of the individual, or peculiarities of the disease in the individual case, are: iodine, iodide of potassium, iodide of zinc, iodide of lead, iodide of iron, iodide of manganese, iodide of magnesium, iodide of mercury, iodide of mercury and arsenic, citro-iodide of iron, potassium sozoiodolate, iodide of sodium, iodide of sulphur, iodide of strontium, iodide of gold, iodide of ethyl, iodide of calcium, iodide of cadmium, iodide of barium, iodide of arsenic, iodide of ammonium, biniodide of guaiacol, hydro-iodate of quinine, hydriodic acid, iodopyrine, iodophenin, iodopinin, aristol, picrol, iodol, iodoform, and europhen. In a general way it may be said of these preparations that the richer they are in iodine and the more readily they part with it the more valuable they are in the treatment of tuberculosis. The value of iodine compounds is undoubtedly dependent upon the iodine, and apparently the nascent iodine given off into the blood or tissues upon breaking up of the compound. In regard to the methods of using iodine preparations the general proposition may be laid down that they are available in proportion as they do not interfere with the digestive process and as they carry the iodine directly into the blood. Three methods of administration commend themselves upon this basis: one is the inhalation method, another the intestinal, and a third the endermic. The inhalation method has been used with good results, and offers an enticing field for further study. In this connection it may be well to place on record a belief which existed years ago in certain walks of life, a fact not generally known to the profession, that the occupation of daguerrotypists as it formerly existed had a tendency to cure tuberculosis. In the process of daguerrotype photography iodine was poured upon a hot plate and the fumes of iodine were given off into the chamber which was used for this purpose, thus exposing the operator to an atmosphere more or less saturated with iodine in a gaseous form. The iodine which was inhaled in this way was no doubt absorbed into the blood, and acted either upon the soil or directly upon the disease-germs. If a way could be discovered by which iodine in the gaseous form could be taken into the lungs in small quantities for a long period of time, the inhalation method would no doubt be found most useful. Something in this line might be accomplished by heating a plate and dropping iodine upon it, thus setting loose the fumes of iodine. In the intestinal method of administering iodine a compound of iodine should be placed in a capsule and given by the mouth two or three hours after meals, so that it may be carried into the intestine

before it is broken up. If administered too near meal-time, chemical changes may take place in the stomach, digestion interfered with, and the desired object of having the nascent iodine, if possible, absorbed into the blood defeated. Because of the chemical changes which may take place in both the stomach and intestine, administration of iodine compounds by the mouth is really the least desirable of the three methods of administration. In the endermic method we have probably the most desirable and most useful method because of non-interference with digestion, and even, continuous administration. Whatever iodine compound may be used should be dissolved in some oil or unctuous substance and rubbed thoroughly into the skin. The parts of the body in which it will be most readily absorbed are the axillary regions and the inner surfaces of the thighs. These parts being freely supplied with lymphatic glands and lymph-ducts, will take up a surprisingly large amount of substance, particularly when it is dissolved in oil. The iodine compounds which are richest in iodine and most readily part with it are aristol, iodol, iodoform, europhen, and iodide of sulphur. Europhen, iodoform, aristol, and iodol are soluble in olive oil and cod-liver oil, and are excellent preparations for the purposes of inunction, because they are not only very rich in iodine, but also readily decompose and give off their iodine. From 3 to 10 grains of any of these preparations in solution may be rubbed into the skin at one sitting, and such inunction may be repeated two or three times a day after tolerance has been established.

Good results have been reported from the use of all of these preparations, especially of iodoform and europhen, whether used by the mouth, by inunctions, or topically in local tuberculosis. When used in the early stages and maintained at the point of tolerance they give almost specific results.

Bromine, an elementary principle similar to iodine, and some of its compounds, have likewise been credited with curative powers in tuberculosis.

Arsenic has also long held a reputation for usefulness in the treatment of tuberculosis, and appears to stand next to iodine in the list of remedies for the creation of artificial immunity. Like iodine it has had hosts of friends and lauders during the last half century, but has never been accepted permanently as a remedy in tuberculosis by the profession at large. The secret of success in its use, as with iodine and other preparations, no doubt lay in the trick of knowing how to use it without interfering with digestion and the normal function of important organs. Arsenic very easily upsets the digestive system, and, unless carefully administered, may also disturb the eliminative organs, especially the kidneys. It therefore should be

used judiciously, and yet fearlessly, for it is only when given to the point of toleration and for a long period of time that its full benefit accrues. The arsenic preparations which have been used in the treatment of tuberculosis are: arsenous acid, arsenic iodide, arsenite of strychnia, arsenate of strychnia, arsenate of iron, arsenate of sodium, iodide of mercury and arsenic, and arsenate of potassium (in Fowler's solution). The arsenic preparations are usually given by the stomach, in solution or in pill-form, after meals. Arsenate of sodium is sometimes used in the form of cigarettes, with a view of taking in the arsenic through the lungs.

There are many other metallic preparations which have been used from time to time by competent men as curative agents in the treatment of tuberculosis, and which in their hands have given favorable results. They all belong to the class of poisonous metals, and whatever merit they may possess is no doubt due to this poisonous quality; therefore they may properly be placed among the remedies for the establishment of artificial immunity. Metals which have been used thus are: silver, gold, lead, zinc, aluminum, antimony, palladium, barium, copper, and mercury. Of the silver preparations, there have been used silver nitrate and silver and potassium cyanide; of the gold preparations, gold chloride, gold cyanide (auric), gold iodide, and gold oxide; of the lead preparations, lead acetate and lead iodide; of the zinc preparations, zinc sulphate, zinc subgallate, zinc chloride, and zinc iodide; of the aluminum preparations, aluminum and postassium sulphate; of the antimony preparations, antimony sulphide and antimony tartrate; of the palladium preparations, palladium chloride; of the barium preparations, barium sulphide and barium iodide; of the copper preparations, phosphate of copper, acetate of copper, and cupro-hemol; of the mercury preparations, calomel, corrosive sublimate, mercury tribromo-phenol-acetate, mercury with chalk, mercury and arsenic iodide, nitrate of mercury, mercury thymol-acetate, and iodide of mercury. The most that can be said of many of these preparations, at the present time, is that they offer suggestions for further investigation. A few of them, however, have been used somewhat extensively, although no definite indications for their use have been given us. The chloride of gold has been used a good deal. The iodide of lead made up in ointment has been much used endermically for tubercular glands. Of the mercury preparations, calomel is extensively used, but more as an adjuvant than a specific for the establishment of immunity. When the portal system has been clogged from overfeeding, a condition which frequently arises, a few doses of calomel given at short intervals restore the entire digestive tract to a working basis. The indication for the use of calomel is the symptom-complex which

people so graphically describe as biliousness, consisting of furred tongue, costive bowels, a feeling of fulness, and a disinclination for food.

Some of the preparations named have been used principally in the treatment of local tuberculosis, such as lupus, and others for the treatment of special symptoms, and will be referred to again.

In the treatment of tuberculosis a number of acids have been credited with curative powers. Those which have been used are: boric acid, carbolic acid, cinnamic acid, gynocardic acid, hydrocinnamic acid, aromatic sulphuric acid, tannic acid, hydrofluoric acid, hydriodic acid, hydrosulphuric acid, lactic acid, phenylacetic acid, orthophosphoric acid, agaric acid, camphoric acid, gallic acid, picric acid, sulphoricinic acid, and sulphuric acid. Many of these enter into the mineral compounds which are credited with curative powers in tuberculosis. Some of them have been used for special symptoms only, and will be referred to in another paragraph. Hydriodic acid has been used quite extensively in tuberculosis of the lungs, and lactic acid has had some reputation in the local treatment of tuberculosis of the larynx.

A great many members of the vegetable kingdom have from time to time been regarded as curative agents in tuberculosis. Usually they have found most favor with the people at large, but some few have won the respect of the profession as well. They have been used in the form of infusions, extracts, exudates, and active principles. Those which have been used in the form of infusions and extracts are: helianthemum (frostroot), hydrastis (golden seal), hydrocotyle (Indian pennywort), ipecac, kalmia (mountain laurel), polyporus (touchwood), salvia (sage), quercus (white oak), rumex crispus (yellow dock), sambucus canadensis (elder), sarsaparilla, sassafras, scrophularia (figwort), serenoa (saw palmetto), stillingia (queen's root), mutisia (scale flower), myrica cerafera (bay berry), myrrha, ostrya (iron wood), phellandrium (water-fennel), podophyllum (may apple), polymnia (bear's foot), prunus virginiana (wild cherry), pulmonaria (lungwort), adhatoda (malabar nut), asclepias syrica (milkweed), asclepias tuberosa (pleurisy-root), berberis aquifolium (barberry), chelidonium (celandine), chimaphilia (pipsissewa), chrysophilum, coto, drosera (youthwort), fucus (seawrack), fumaria (fumitory), gentium, granatum (pomegranate), sycocarpus, thapsia (deadly carrot), and belladonna. The active principles and exudates which have been used are: picrotoxin (cocculus indicus), hamamelin, corydalin (squirrel corn), hyoscyamine, teucrin (water-germander), lycopin (bugleweed), alantol, menthol (peppermint), cotoin, asclepin, agaricin, atropia, heroin, codeine, morphine, opium, cocaine cantharidate, cocaine lactate, chimaphilin, veratrine, cetrarin, cimicifugin. Comparatively few of

these preparations are generally known, or even named, outside of dispensatories and indexes of drugs, and yet valuable resources may lie hidden behind them, waiting for some keen observer to bring them into use. The mere fact that they have attracted attention at one time or another, and that they have given encouragement to some one, is reason why they should be further looked into. Truth sometimes lies hidden even in popular beliefs, and now that we are studying the treatment of tuberculosis from new points of view it would not be amiss to look carefully into popular remedies. Of the preparations mentioned, those which have received professional endorsement are: opium and its derivatives, belladonna and its derivatives, agaricin, ipecac, balsam of Peru, balsam of Tolu, tar, and turpentine and its derivatives. Some of these are of great value in treatment of special symptoms, and will be spoken of in separate paragraphs. At one time in the history of medicine ipecac was used quite extensively in the treatment of tuberculosis; not, however, with any idea of exercising a specific influence, but for the purpose of producing emesis, which was then believed to exercise a beneficial effect upon the course of the disease. The drug was not used momentarily or intermittently, but in large doses and for a considerable period of time until toleration had been established. Paradoxical as it may seem to us, good results were reported from this mode of treatment. The two balsams, tar and turpentine, are still used by some old-time practitioners with apparently satisfactory results. The real value of these preparations remains to be determined.

The volatile oils have in recent years attracted much attention as specific remedies in tuberculosis, and have received such endorsement on the part of scientists as to merit further study. The preparations which have in particular attracted attention are the oil of thyme, oil of wintergreen, oil of rosemary, oil of marjoram, oil of geranium, oil of cloves, oil of anise, oil of lavender, oil of cinnamon, oil of eucalyptus, oil of niaouli, and oil of peppermint. They have been used by inhalation, by inunction, by the stomach, and topically. They are worthy of consideration for combination with other remedies, and offer a good field for future investigation. They are also excellent solvents for some of the metallic compounds, especially the iodine preparations, and may be advantageously combined with olive oil when the endermic method of medication is practised.

A number of drugs, which cannot well be classified under the headings given have been used in the treatment of tuberculosis. They are: methylic alcohol, formaldehyde, ichthyol, eugenol, gaduol, cinnamyl, acetaminol, thiosinamine, gyno-cyan-auridzarin, chloroform, and cantharidin.

The treatment of tuberculosis as based upon disease-germs which

set up mixed infection or which colonize side by side with the tubercle-bacillus opens up a large, interesting field of study as yet uncultivated. We are really only beginning to realize what consumption in the classic sense is, and to understand why it has so long checkmated the skill of the physician. The laboratory is gradually clearing up this complicated question, and with the aid of clinical observation is determining for us what pathogenic organisms fraternize with the tubercle-bacillus and the manner in which the various organisms operate or coöperate in the devastation and the subjection of the host. There is clinical evidence at hand which seems to indicate that some pathogenic organisms, such as the typhoid bacillus, the germ which produces smallpox, and the diphtheria-bacillus, seldom invade an organism that is already a host of the tubercle-bacillus. But other pathogenic organisms seem not only to work in harmony, but also to be attracted by the tubercle-bacillus, while some few will merely colonize side by side.

The pathogenic organisms which seem to fraternize with the tubercle-bacillus are of two kinds: (1) those which run their cycles concomitantly with the tubercle-bacillus, and (2) those which depend for their implantation upon the damage already done to the tissues by the tubercle-bacillus, and which work in close harmony with it for the destruction of tissue. To the first category belong all those germs which set up inflammation of the respiratory tract and give rise to the clinical phenomena which are ordinarily called colds, the influenza-bacillus, and the pneumococcus. To the second category belong the various pus-producing germs, such as the streptococcus and the staphylococcus.

The germs which give rise to the disorders called colds, the influenza-bacillus, and the pneumococcus only affect tuberculosis to the extent of the depression which they set up in the individual and the irritation which they may produce in the organ in which the tubercle-bacillus colonizes. They apparently do not coöperate with the tubercle-bacillus for the destruction of tissue nor in any sense fraternize with it. They may, however, set up serious complications nevertheless, because the diseases which they produce are very depressing for the time being, leaving behind favorable soil for the tubercle-bacillus, and may stimulate the growth of tubercular colonies by the local irritation which they set up; what is still worse, they may attract pus-producing germs to the affected organ and introduce them into the tubercular colonies. In fact, tuberculosis is rarely recognized until attention is called to it by the existence of a complication of a cold, influenza, or pneumonia. It is in the wake of one or another of these diseases that the physician almost invariably discovers the presence of tuberculosis.

The treatment of these complications is preventive and curative. Colds and influenza are highly contagious, and pneumonia is probably infectious. This view is contrary to popular belief and to the ideas which formerly governed the medical profession; hence it is difficult to make patients accept it seriously. There, however, can be no longer any doubt about the correctness of it, and it is of the very greatest importance to a tubercular subject that he fully comprehend it and enter into the spirit of it with earnestness. Owing to the great prevalence of colds during the winter season, and of influenza when influenza is epidemic, it will be found difficult for him to keep away from every one who has them. He should, however, make every effort to do so; and when he is compelled to be in intimate association with persons suffering from such diseases it would be well for him to insert into his nostrils plugs of cotton saturated with some aseptic oil, and to cleanse the upper respiratory tract frequently with an aseptic solution. Exposure to pneumonia will be even more difficult to avoid, because we do not yet know by what method the disease is conveyed from one person to another. Fatigue is a predisposing cause, and he should therefore avoid fatigue. He had also better keep away from persons who have pneumonia.

If a tubercular subject is so unfortunate as to contract cold or influenza in spite of his precautions, he should seek treatment early. The treatment is the same as when tuberculosis does not exist, except, possibly, that it should be more heroic, and that the patient should at once be put at absolute rest and be kept so until he has recovered. While the inflammatory condition of the mucous membrane is still confined to the nose and throat small doses of calomel may be given at short intervals, atropine, aconite, and opium may be administered, aseptic applications should be made to the nasal passages, and astringent gargles used for the throat. When the inflammation has extended beyond the pharynx into the bronchial tubes the various ammonium preparations, quinine, diffusible stimulants, and digitalis will be found to be useful remedies. The farther the disease advances the more efficient the ammonium preparations will be found to be. The ammonium preparations which are available for this purpose are: muriate of ammonium, carbonate of ammonium, borate of ammonium, iodide of ammonium, sulphoricinate of ammonium, bromide of ammonium, and benzoate of ammonium. The muriate, the benzoate, and the carbonate are the preparations most frequently used, probably because they are the least irritating to the stomach. The treatment should be persevered in and the patient kept at rest until all evidence of the complication has disappeared and the activity which it set up in the tubercular process has subsided.

The curative treatment of pneumonia as a complication of tuber-

culosis is practically the same as that of croupous pneumonia when it occurs alone. Croupous pneumonia is not a frequent complication of tuberculosis, and when it occurs it seems to run a milder course than usual, there apparently being an antipathy between the tubercle-bacillus and the pneumococcus. But when the two germs colonize side by side, the pneumonia is nearly always a damaging complication to the tubercular subject, because of the great depression which it leaves in its wake, and the long interference with regular treatment which it causes. Occasionally the pneumonia exercises a beneficial influence upon the tubercular process; but usually it checks the progress to recovery many months, even when it does no permanent injury. The treatment should be stimulating throughout, with the patient at absolute rest. Every effort should be made to keep up strength by overfeeding; and the case should be managed with one thought in mind—to bring the patient through with as little damage to the organism and as little stimulation of the tubercular process as possible. Convalescence is apt to be slow and tedious, and while it is going on the patient must be carefully watched, and kept in the best possible condition.

Mixed infection with pus-producing germs brings about the most serious complication in tuberculosis with which the physician has to deal, and tests his knowledge and skill to the utmost. It ever has been the opprobrium of scientific medicine and the harvest of the quack. With it come chills, fever, sweats, distressing cough, profuse expectoration, alternate days of well-being and extreme illness, an ever-abiding hope of recovery with a perceptible waning of vital resources. The pus-producing germs seem not only to have the power of devastating, on their own account, but of preparing soil for the tubercle-bacillus, so that scarcely has one tubercular colony run its course when a new one is in process of formation and the patient has no longer intervals of rest for recuperation, but suffers from one bad spell after another in such rapid succession that there seems really to be no intermission, but a constant downward course. When this complication has set in, our duty is to promptly get rid of it; and, if this cannot be accomplished, to treat the distressing symptoms in the hope that nature may ultimately work out what art cannot. The remedies at our command for these purposes are: creasote and its various combinations, derivatives, and congeners, cinchona and its derivatives, opium and its derivatives, and the antisudorifics. The creasote combinations are: benzoate of creasote, carbonate of creasote, chlorhydrophosphate of creasote, calcium guaiacol, guaiacol benzoate, guaiacol carbonate, guaiacol phosphate, guaiacol-salol, guaiacol cinnamate (styracol), and guaiacol succinate. Creasote, its preparations and derivatives, in large well-sustained doses, seem to

attack the pus-producing germs directly, as they abate chills, fevers, sweats, and coughs. In most cases they accomplish these ends better than quinine, coal-tar products, opium, and the antisudorifics, while at the same time making for recovery. They, however, must be given in very large doses, which can only be reached by gradual steps. With beechwood creasote a good plan is to begin with 1 drop three times a day, and increase the dose by 1 drop every other day until from 40 to 50 drops three times a day are given. The best menstruum in which to give it is hot water, and the quantity of hot water should be increased with the dose of creasote, so that when the maximum dose is given at least one pint of water will be taken. Milk, wine, and oil are likewise good menstruums, and may be used when the patient objects to hot water. Some care should be exercised in the selection of a menstruum, as the stomach and digestive system may be upset by the menstruum. Whiskey, brandy, and wine are sometimes used as menstruums, and are excellent so far as disguising the creasote is concerned, but may do serious injury when taken in quantities large enough to accomplish the purpose, by congesting the liver and interfering with the action of the kidneys. Water is not only a good diluent, but has the advantage over all other menstruums in that it in no way interferes with the digestive and nutritive systems, and instead of embarrassing the kidneys protects them by supplying a large amount of diluent for eliminative purposes. The derivatives of creasote are preferred to creasote by many practitioners, because they are more pleasant to take and seem to be borne better by the stomach. Like creasote, to be effective, they must be given in gradually increasing doses until a point of tolerance is reached, and this must be maintained for a long period of time. They are much more expensive than creasote, a matter which has to be considered with many patients.

There are congeners of creasote and its derivatives which may be substituted for it, and which in some cases may give better results than the creasote itself. These are: turpentine, terebene, terpene hydrochlorate, terpin hydrate, terpinol, balsam of Tolu, balsam of Peru, camphor, camphor salicylate, tar, helenin (camphor derivative), carbolic acid, para-mono-chloro-phenol, phenol and sodium sulphoricinate, phenocoll, phenocoll hydrochlorate, phenacetine, euphorin, meth-acetine, camphorated beta-naphtol, thermodin, asaprol.

During the existence of mixed infection expectoration should be encouraged and softening of the infected nodules promoted. In the matter of expectoration assistance can be given by the ammonium preparations and by other stimulants of the bronchial mucous membrane, such as cimicifuga, ipecac, senega, etc. Necrosis and softening may be promoted by external applications of poultices, hot-water

bags, etc.; but care must be exercised not to prostrate the patient by heat and the sweating which may be produced by hot applications.

When the patient becomes thoroughly poisoned with the products of mixed infection—as he but too often ultimately does—the most difficult part of the physician's task begins, namely, to keep him from suffering. It then becomes a struggle for prolongation of life and a condition of well-being rather than for cure; and with this end in view symptoms must be treated as they arise. Severe chills, high fever, distressing cough, profuse sweats, diarrhœa, oppressive lassitude, sleeplessness, and agonizing shortness of breath are liable to occur under the best management. The keen edge of all this suffering may, however, be dulled, and sometimes even a condition of comparative well-being established by a judicious use of the drugs at our command. Here the opiates, narcotics, antiperiodics, antisudorifics, and astringents have their legitimate field of usefulness. Inasmuch as the chills, fever, and sweats are due to the presence of the pus-producing germs, great discretion should be exercised in the use of drugs which may pen up those germs. Opium is frequently abused in this regard in the desire to stop cough. As cough is nature's effort to get rid of offending matter, it should not be interfered with further than is necessary for the comfort of the patient. A good plan is to give full doses of opium at night to insure sleep, and to give it sparingly in daytime, just enough to prevent unnecessary cough. Care should be exercised that complete evacuation of cavities takes place daily. Evacuation may be promoted by certain attitudes, such as lying upon one side or the other, to allow the secretions of cavities to gravitate to the place of exit. To some extent cough can be regulated by will-power. In the morning when the patient arises he should encourage cough and make every effort to evacuate cavities thoroughly and remove all accumulated secretion and broken-down tissue. Once having cleaned out the lungs, so to speak, he should repress cough as much as possible, and it is remarkable to what degree he can learn to do this by sheer force of will. When an opiate is necessary the preparations from among which a selection may be made are: codeine, heroin, deodorized tincture of opium, paregoric, and hyoscyamine. When there is broken-down tissue enclosed in a cavity which does not find exit, cough is apt to become so severe as to bring on retching and vomiting. In this condition opiates will have to be given in heroic doses to overcome reflex irritability. Bromide of sodium and dilute hydrocyanic acid may be added advantageously to the opiate.

For chills and fever, cinchona bark and its derivatives and the coal-tar products are indicated. A grain each of quinine and phenacetine every two hours will frequently prevent the chill and keep down the

fever. If the chill and fever are prevented, the sweat is not apt to occur. When the sweat occurs and becomes so profuse as to interfere with the comfort of the patient, an effort should be made to stop or modify it. A great many drugs have been used for this purpose, none of which are infallible; but usually a successful remedy can be selected. The drugs that have been used are: belladonna and its derivative atropia, aromatic sulphuric acid, camphoric acid, tannic acid, gallic acid, ergot, dilute orthophosphoric acid, agaricic acid, agaricin, aluminum and potassium sulphate, iron sulphate, lead acetate, zinc sulphate, zinc subgallate, potassium camphorate, potassium ferrocyanide, potassium tellurate, cotoin, chimaphilia (fluid extract), salvia (fluid extract), polyporus (fluid extract), hydrastis (fluid extract), granatum (alcoholic extract), sulfonal, and picrotoxin. Sometimes it is possible to combine one or another of these remedies with other drugs which are already being used.

Diarrhœa frequently becomes a very annoying complication during the later stages of tuberculosis. When the bowel involvement is not very extensive much can be accomplished in the way of checking it by placing the patient on liquid diet. If this does not suffice, a mild astringent may be given. Ultimately, however, powerful astringents and opiates will have to be resorted to. Astringents which have been successfully used for this purpose are: bismuth subnitrate, bismuth salicylate, bismuth and sodium phosphosalicylate, fluid extract of coto, tincture of catechu, misturæ cretæ, acetate of lead, and nitrate of silver. The old lead-and-opium pill is one of the best remedies when the diarrhœa is very severe. For the feelings of lassitude and extreme weakness which sometimes afflict the patient during his last days, diffusible stimulants give most relief. For sleeplessness, opium, chloral, sulfonal, and chloralamid are the most reliable remedies. For shortness of breath, oxygen, opium, heroin, caffein, and nitroglycerin may be tried. Absolute relief for this condition can seldom be attained.

SCROFULOSIS.

By WALTER CHRYSTIE, M. D.

Before entering into the subject of the treatment of scrofulosis a few words as to the nature of the diathesis are necessary. It should be understood that scrofulosis is not a *disease*, but a condition predisposing to certain disease-processes, and particularly to hyperplasia, tuberculous inflammation, and caseation of lymph-glands. It has no characteristic anatomical lesion or pathognomonic symptom, and when it is said that a person is scrofulous, it is meant that in him any peripheral inflammation, however slight, is prone to be prolonged, and that chronic inflammation of the lymph-glands into which the inflamed parts drain is almost certain to occur. Hence the inflammation about a carious tooth, an acute tonsillitis, or an excoriation of the scalp, which ordinarily would be a matter of a few days' duration, in a scrofulous person is prolonged, and causes tenderness and tumefaction of the cervical lymph-glands. Furthermore, the scrofulous offer a peculiarly favorable soil for the growth and multiplication of tubercle bacilli: a slight bronchitis in a scrofulous individual may open the way for the entrance of the bacilli, and be the starting-point of phthisis; and for the same reason many of the inflammations to which the diathesis predisposes are tubercular. It is this tendency to tubercular disease which make the management and treatment of a scrofulous child or adult extremely important, for by proper care the tendency may be thrown off and the normal resistance to the inroads of the bacillus tuberculosis acquired.

Prophylaxis.

The prophylaxis of scrofulosis should begin before birth by careful attention to the health of the mother during pregnancy, particularly if she has any previous history of scrofulous or tubercular disease. No special measures are required at such times, but all abnormal symptoms of pregnancy, such as excessive vomiting, diarrhœa, albuminuria, etc., must be treated promptly on the lines laid down in the textbooks on obstetrics. The woman's nutrition must be kept as nearly perfect as is possible.

In children whose parents have suffered from any of the manifestations of scrofula, such as enlarged lymph-glands, or from tubercular disease of the lungs or bones, careful hygienic management and attention to every slight local inflammation, be it only a fissured lip or splinter under the finger-nail, is important, as by such attention the susceptibility to tubercular invasions may be entirely removed.

As most scrofulous persons are prone to attacks of catarrhal inflammation of the respiratory mucous membrane from chilling of the skin, and as such attacks are certain to be prolonged and frequently result in hyperplasia, tubercular infiltration, and caseation of the bronchial and mediastinal lymph-glands, the thickness and quality of the clothing must be carefully regulated, not only with reference to the season, but to minor changes in temperature. At all seasons the clothing should be of the material which is the poorest conductor of heat. For many years woollen under-clothing has been considered almost a necessity in cold weather, to prevent chilling of the body-surface and the resulting catarrhs. Recent experience, however, would seem to show that while wool is a poor conductor of heat, and while it absorbs moisture readily, it parts with moisture slowly and remains damp for a long time after even slight perspiration. Careful observation during the past few years has proved that other materials are better for the under-clothing of children who "take cold" readily. Linen and silk are the materials which the writer prefers. There is a material on the market, known as the "Deimel linen mesh," which has been found most satisfactory, although in the coldest weather and in those who are very sensitive it is well to wear an additional suit of very thin silk. There should be three sets of under-clothing—moderately thick for winter, intermediate for spring and autumn, and thin for summer. The shirts should button well up to the neck, and the sleeves must reach nearly to the wrists, the drawers, of course, extending to the shoes. Diapers should be changed as soon as possible after they become wet, not only to avoid chilling, but to prevent dermatitis of the perineal region from the irritation and poulticing effect of the urine. After exertion, in both children and adults, if there is even slight moisture of the skin, it is well to remove all the clothing in a warm room, rapidly rub the body surface with a damp sponge, then with a soft, warm towel, and put on dry clothing. Indeed, in scrofulous children it is good practice habitually to change the clothing in the middle of the day.

Bathing.—Bearing in mind the extreme sensitiveness of the scrofulous to the effects of cold, the importance of carefully regulating the temperature of the baths is evident. Tub-baths should be entirely avoided; sponge- or shower-baths are sufficient for cleanliness, abstract but little heat, and as a rule are gently stimulating, whereas tub-baths

in persons whose general nutritive activity is impaired are almost invariably followed by blueness of the extremities and an uncomfortable sense of chilliness and depression.

The proper temperature of the bath must be determined for each case, the guide being the lowest temperature that is promptly followed by reaction. In most cases this temperature will be found to be between 85° and 90° Fahr. in winter and 75° and 80° in summer. The temperature of the room in which the bath is taken should be not less than 72°. The process of bathing must be completed in from one to two minutes, and the body surface should be immediately rubbed with a soft warm towel, and afterward with the naked hand. It is well then for the patient to practise vigorously for a few moments some of the light calisthenic exercises. As to the proper time of day to bathe, in the majority of cases immediately after rising in the morning is preferable. A bath at night, particularly a cool sponge-bath, is sufficiently stimulating to interfere with sleep, whereas if taken in the morning the invigorating effects continue throughout the day.

Sea-bathing is undoubtedly of value to the scrofulous, perhaps partly from the small amount of iodine in sea-water, but chiefly because the salts increase the activity of the cutaneous glands, and because the bather is actively exercised. Jacobi writes that "salt water is preferable to plain water, and sea-bathing to either." Treves thinks that the effects of sea-bathing are chiefly mental, and asserts that it is absurd to bathe in artificial sea-water. D'Espine[1] has studied the effects of sea-air and bathing upon 308 children between the ages of four and a half and fifteen years, suffering from various scrofulous (tubercular?) affections, sent to the Mediterranean coast of France. Each child received about forty-five baths during a period of six weeks. Forty-eight cases were cured, 215 improved, 44 were unimproved, and 1 died.

Casse[2] claims that in many cases residence at the sea-shore, without either medical or surgical treatment, is sufficient to cure scrofulous disease. Many other writers, chiefly French, have advanced indubitable evidence that sea-air and bathing are valuable resources in the treatment of scrofulous affections. Many of the good effects are undoubtedly due to other factors, such as change of climate and scene, rest, regularity of meals, etc.; but the writer is convinced that salt baths stimulate nutrition, and is in the habit of directing scrofulous persons to add a small amount of sea-salt to the bath once or twice a week.

Surf-bathing has one very serious disadvantage—namely, that the bather is tempted to remain in the water so long that his cutaneous circulation is depressed and his extremities and lips become blue—a

[1] *Revue méd. de la Suisse Romande*, Sept., 1888.

[2] *Bulletin de l'Acad. Royale de Méd. de Belgique*, Jan., 1888.

condition which of course interferes more or less with nutrition, and which is carefully to be avoided by the scrofulous. In children under six or eight years of age surf-bathing is not admissible.

Climate.—Next to the dietetic management, the most important matter in the treatment of a scrofulous child or adult is the selection of a suitable climate. No absolute rules for climatic treatment can be laid down, but in general it may be said that dryness, a large proportion of sunshine, and an equable temperature are essentials. Practically, the climates best suited to the treatment of phthisis are also those most appropriate for the scrofulous, and for more detailed directions than can be given here the reader is referred to the articles on "Tuberculosis" and "Climate."

Here let it be said that sanitaria, hotels, and boarding-houses frequented by consumptives should be carefully avoided by the scrofulous. Even if the etiological relation of the bacillus to tuberculosis is not established, in scrofulosis the tissues are peculiarly receptive to the causes of tuberculosis, and few will deny that some of these causes are increased by the aggregation of tuberculous persons. A scrofulous person suffering from bronchitis and living in an infected house is extremely likely to develop pulmonary phthisis; whereas, the same person living in pure mountain- or sea-air may pass through many attacks of bronchitis, none of which will leave any sequelæ.

The efficacy of sea-air in eradicating the scrofulous diathesis and its manifestations is admitted by all writers, and has been especially dwelt upon by Deligny,[1] who made a large number of observations upon scrofulous children treated in L'Hôpital de Berck on the coast of France. Frederick Treves[2] also writes that the records of the Margate Infirmary for Scrofula support the fact that sea-air possesses a curative influence upon scrofula, by showing a large number of cures and by a still larger number of cases of marked improvement; but he adds that "the greatest advantage is observed in instances of acquired struma, in cases where the disease has developed in the purlieus of a great town, and in those patients, in fact, to whom sea-breezes and outdoor exercises offer the most striking possible contrast to their previous surroundings."

Cases will occasionally be met with which do not improve in a coast climate, or which improve exceedingly slowly notwithstanding the utmost care in the selection of diet. Such cases will often improve rapidly if removed to a dry, moderately elevated mountainous region.

It is extremely difficult, and often impossible, to determine in a given case which climate will be the most beneficial. Treves thinks that the cases which do not improve at the seaside are usually those

[1] *De l'Adenopathie cervicale chez les Scrofuleux*, Thèse de Paris, 1879.

[2] *Scrofula and its Gland Diseases*, New York, 1882.

with a "phthisical tendency," as well as many cases of eczema, some cases of strumous ophthalmia, and a few cases of lupus. The writer's experience has been that cases in which there is marked anæmia, muscular debility, or exhaustion from the presence of the complications, such as glandular suppuration, bone disease, etc.—in other words, cases with well-marked tubercular disease excluding pulmonary phthisis—usually improve more rapidly in sea-air, and that cases of the scrofulous diathesis alone are better in mountain-air.

Many cases will gain in weight and appearance in a coast climate for a few months, then come to a standstill or even retrograde. Under such circumstances removal inland will usually be followed by renewed improvement. Indeed, in some cases frequent changes in climatic surroundings are necessary in order that the improvement may be continuous, and in all cases a week or two at the sea-shore can do no harm preparatory to a more prolonged sojourn in a mountain climate.

As a winter sea-shore climate the western coast of Florida possesses many advantages, there being a greater number of cloudless days than on any part of the Atlantic coast. During the winter months the temperature is very equable, seldom falling below 50° Fahr. There are also many facilities for outdoor amusements, such as fishing, boating, and shooting; and a reasonable amount of amusement is important in the climatic treatment of any disease.

Atlantic City, on the New Jersey coast, is an excellent winter resort, although of course much colder than the Florida coast. The temperature is higher during the winter than that of most northern sea-coast resorts, partly owing to the fact that a branch current of the Gulf Stream approaches here within sixty miles of the shore, and also because the direction of the Gulf Stream opposite Atlantic City is such that the prevailing ocean-winds must pass from three hundred to five hundred miles over the warm current. Land-breezes, however, are about the same as elsewhere on the New Jersy coast, but the total amount of wind is nearly 30 per cent. less. The rainfall is said to be less than at any other point on the Atlantic coast of the United States, with the exception of Portland, Maine.

The winter climate of San Diego, on the coast of Southern California, is mild, and, although rather damp, is beneficial to many cases of scrofulosis. Lindley[1] has called attention to the Conchilla Valley in the eastern part of San Diego county, California. The valley is 360 feet *below* sea-level, the atmosphere dry, and the pressure of course somewhat increased. Good effects in the treatment of phthisis have followed residence there.

Excellent summer resorts are Cresson, Pennsylvania, the Adirondack Mountains and surrounding region, the pine belt of New Jersey, and the

[1] *Annual of the Universal Medical Sciences*, vol. v., 1889.

mountains of Virginia. The mountains of Georgia and North Carolina are suitable regions in both summer and winter.

Diet.—Dietetic management is so important in the treatment and prophylaxis of scrofulosis, particularly in infants, that the writer will dwell somewhat at length upon the subject, believing that often the future health of the individual depends alone upon the methods of feeding during infancy and early childhood.

Until within the past few years it was very generally insisted upon that infants of tubercular or scrofulous parents should be nursed at the breast, and it has even been contended that well-marked scrofula in the mother is no contraindication to her nursing her child, and that unless she be phthisical it is safer not to resort to artificial food until the child has reached the age of several months. Undoubtedly, human milk, even from a scrofulous woman, is better than improperly selected and prepared artificial food, and it is also true that normal human milk is much better pabulum for infants than the most carefully prepared artificial food; but in most instances the milk of a scrofulous woman will not have the normal amounts of fat and albuminoids. Fat, an abundance of which is important to healthy infants, but vastly more important to the scrofulous, will usually be deficient in quantity. Hence, when the question arises of how to feed a scrofulous infant, it must first be decided whether the mother's health will warrant the drain upon it of lactation. If this is decided in the affirmative, a careful estimation of the fats and albuminoids in her milk must be made, and if either varies much from the normal amount artificial food or a wet-nurse must be resorted to.[1]

Taking the milk analyses of Meigs[2] as on the whole the most accurate that have been made, the fat in milk for a scrofulous child should not vary much from 4.2 per cent. (the normal amount) or the albuminoids from 1 per cent. In some cases, although chemical analysis shows a normal proportion of the various constituents of the mother's

[1] Nias (*Lancet*, November 15, 1890) suggests the following method of estimating the amount of fat and albuminoids in milk, which he considers sufficiently accurate for clinical purposes: Add enough liquor potassa to the sample of milk to render it distinctly alkaline; place in a test-tube, boil, and set aside in a warm room for a few hours. The fat will rise to the surface, and the amount may be estimated by a graduated rule placed at the side of the tube. To determine the amount of albuminoids remove the layer of fat with a pipette, add sufficient acetic acid to the remainder to render it acid, boil, and again set aside in a warm room. All the albuminoids will be precipitated, and may be estimated in the same manner as the fat. The process would be much facilitated by using a test-tube graduated in hundredths. There is now on the market a convenient little instrument, devised by Holt, consisting of a lactometer and graduated glass, by means of which the fat and albumenoids can be readily estimated.

[2] *Milk Analysis and Infant-feeding*, Philadelphia, 1885.

milk, the child does not thrive upon it, but gains weight slowly or not at all, and shows evidences of imperfect digestion. Under these circumstances a wet-nurse may be resorted to if one can be found who fulfils all the well-known requirements; but with the additions of the past few years to our knowledge of artificial foods and feeding, breast-feeding can no longer be considered an essential in the management of scrofulous infants.

In selecting a food for a scrofulous child the indications are exactly the same as in the case of a normal infant—namely, to give that which chemistry shows is the nearest in composition and in behavior under various tests to the food provided by nature.

Escherich has shown that milk drawn from the breast of a healthy woman into sterilized receptacles can be kept for some days without undergoing fermentative or putrefactive changes; in other words, normal human milk is free from micro-organisms. The importance of this condition is now universally recognized, and sterility may be considered an essential quality of all foods for infants. In the scrofulous its importance is, if possible, greater than in normal infants, for in them the introduction of a few of the bacilli of tuberculosis is very likely to result in tabes mesenterica or tubercular enteritis. Milk can be rendered sterile by one method only—namely, by maintaining it at a temperature of 212° Fahr. for from ten to thirty minutes in the various forms of sterilizers, which are too well known to need description. This method, however, has serious disadvantages, to be shortly mentioned, and should seldom, if ever, be resorted to.

The artificial food that approaches the nearest to human milk in its chemical and physical properties is the mixture of cow's milk, lime-water, and milk-sugar proposed by Meigs, or some of its modifications. Meigs's mixture consists of 10 cc. of cream, 5 cc. of milk, 10 cc. of lime-water, 15 cc. of water, and 2.2 grammes of milk-sugar.

Meigs's original directions for preparing this food were somewhat elaborate and troublesome, but subsequently[1] he described a much simpler method, chemical analysis showing that the amount of the various constituents was about the same by either method. The simplified method has the very great advantage that cream does not have to be obtained separately, for in cities the cream furnished by dealers is always either twelve or twenty-four hours older than the milk, and hence is more likely to become sour: "One quart of good ordinary milk is placed in a high pitcher or other vessel, and allowed to stand in a cool place for three hours; then one pint is slowly poured off from this, care being taken that the vessel is not agitated, the object being to

[1] *Arch. of Pediatrics*, Dec., 1889.

obtain the upper layer of fluid, rich in fat, and leave the lower, comparatively poor, portion behind. When the child is to be fed, there are taken of this weak cream three table-spoonfuls, of lime-water two table-spoonfuls, and of sugar-water three table-spoonfuls, the sugar-water being made in the proportion of eighteen drachms of milk-sugar to a pint of water." This of course makes only four ounces, sufficient for infants less than two or three months old. For older infants larger amounts of the mixture must be given, still retaining the relative amounts of the ingredients.

Holt[1] has objected, with reason, that Meigs's mixture is much more strongly alkaline than human milk, and that the taste of the lime-water is evidently unpleasant to many infants. For these reasons he dilutes the lime-water two-thirds, the dilution rendering the mixture slightly but distinctly alkaline. Holt also uses cream obtained by the centrifugal process, diluted one-fourth with water, which contains more fat, raising the percentage of fat in the mixture to 4, that of the original mixture of Meigs being 3.50.

There has been a tendency to believe that in a sterilized mixture which is chemically nearly identical with human milk we have reached perfection in artificial infant-foods. To this we desire to protest, without in any way undervaluing the importance of thorough sterilization. The prolonged high temperature to which the milk is subjected has no parallel in nature, and must necessarily produce certain changes. The writer has more than once seen a child thriving on unsterilized Meigs's mixture become dyspeptic and constipated when the same food was given sterilized, and he has been obliged to assume the risks of giving raw milk in order to avoid the more imminent dangers of gastro-intestinal catarrh and malnutrition. Furthermore, careful observation is convincing that to be properly nourished an infant must take a slightly larger amount of sterilized than of unsterilized milk. These disadvantages are exaggerated in the feeding of infants with an inherited scrofulous diathesis, in whom complete digestion and thorough nutrition are necessary. The experiments of Raudnitz, Vasilieff,[2] and others have shown that in both man and the lower animals larger quantities of boiled than of unboiled milk are necessary to maintain the body-weight. Vasilieff's experiments upon healthy men were apparently carefully conducted, and show that the amount of non-assimilable albuminoids is about 5 per cent. greater in boiled than in unboiled milk, and that nearly 50 per cent. less fat is appropriated from boiled milk, the deficiency of assimilable fat being a serious disadvantage to the scrofulous.

[1] *Cyclopædia of Diseases of Children*, vol. i. p. 323.
[2] *Provincial Med. Journ.*, January, 1890.

Hirst,[1] in searching for the cause of these changes, had a number of analyses of sterilized milk made, the results of which indicate that a temperature of 212° Fahr. produces very decided alterations in the albuminoids, fat, and sugar. The most important changes are in the fat, and consist in the freeing of a very small amount, and an alteration of the envelopes of the remaining fat-globules which lessens their tendency to coalesce. On churning sterilized and unsterilized samples of milk it was found that with the latter butter was formed in one-third of the time required by the former. Assuming, then, that the difficulty in digesting sterilized milk lay in toughening of the albuminoid envelope of the fat-globules, Hirst logically concluded that partial predigestion of the envelope would render the escape of the fat materially easier. To determine the truth of this he churned small quantities of milk and cream mixture which had been partly predigested by pancreatin and sodium bicarbonate, with the result that butter formed freely in less than four minutes. In a similar sterilized but not predigested mixture no butter was produced for twelve minutes, and then only in small quantities.

Theoretically, then, partial predigestion of milk and cream mixtures before they are sterilized would seem to be a great improvement in our methods of infant feeding, and the inference is supported by the results in twenty-one infants in the Philadelphia Hospital fed on this plan; and we have no hesitation in affirming that the method should be tried in all artificially-fed scrofulous infants that do not thrive and gain weight as they should. The directions for preparing the mixture and for feeding are as follows:

"1. Have ten nursing-bottles prepared clean every morning.

"2. Take

Cream	5 ozs.
Milk	2½ ozs.

"3. Put in skillet; add pancreatin powder; heat over alcohol flame for six minutes; stir and sip constantly; *do not overheat.*

"4. Of this mixture, put in each bottle 6 drachms (for a 2-oz. bottle). Use funnel.

"5. Add to each bottle 10 drachms sugar solution.

"6. Stopper the mouth of each bottle with dry, baked cotton, and sterilize for twenty minutes.

"7. Set aside to cool.

"8. Before use, put bottle in warming-cup; apply nipple immediately before giving it to infant.

"Make sugar solution by dissolving 1 ounce sugar of milk (one powder) in a pint of warm water.

[1] *The Medical News*, Jan. 31, 1891.

Age.	Interval.	Number of feedings in 24 hours.	Amount of food at each feeding.	Total amount in 24 hours.
1st week	2 hours.	10	1 oz.	10 ozs.
2d to 4th week	2 hours.	9	1½ oz.	13½ ozs.
2d to 3d month	3 hours.	6	3 ozs.	18 ozs.
3d to 4th month	3 hours.	6	4 ozs.	24 ozs.
4th to 5th month	3 hours.	6	4–4½ ozs.	24–27 ozs.
6th month	3 hours.	6	5 ozs.	30 ozs.
8th month	3 hours.	6	6 ozs.	36 ozs.
10th month	3 hours.	5	8 ozs.	40 ozs.

"The pancreatin powder, for the quantity indicated on the card, consists of

℞. Pancreatin, 2½ grains;
Bicarbonate of sodium, 5 grains."

Pasteurization, which consists in raising the temperature of the milk to 160° F. for about twenty minutes, has almost entirely taken the place of sterilization. By this means all germs are destroyed, although not the spores, and we have a milk which is practically sterile without its digestibility being seriously impaired.

There are a certain number of scrofulous infants in whom fat is deposited with unnatural ease and rapidity, and often at the expense of the other tissues. In such cases it may be well to reduce slightly the amount of cream. For instance, in the mixture of Hirst 4 or 4½ ounces of cream, instead of 5, might be given. But the weight of the child must be carefully watched, and should it cease to gain it is better to return to the original amount of cream. Ass's milk and goat's milk, both of which have been recommended, are not suitable foods for the scrofulous. The former contains too little fat, the latter an excess of both fat and albuminoids.

During and after the period of weaning milk must still be the chief article of diet, and in the city should be sterilized, or at least well boiled, as soon as received, in order to reduce to a minimum the danger of tubercle bacilli entering the system by way of the intestines. In the country, where the cows from which the milk is received can be watched, sterilization of milk for children older than one year can hardly be considered necessary. In most cases between the fourteenth and eighteenth month it is well to add a small amount of starch to the diet of scrofulous children. At first almost any of the many preparations of the cereals may be given, those being finally selected which are digested most readily. The stools must be watched, and if they become clay-like in consistence, if they are covered with an excess of mucus, or if particles of undigested food appear, the best preparation for that case has not been given or has been given in excess.

"Wheatena,"[1] given in the form of a thin mush, has proved very satisfactory in the writer's hands. It is said to contain all the elements of the wheat-berry but the husk—in most other preparations of wheat the layer of gluten-cells is removed with the husk or bran. In wheatena the starch-granules have already been ruptured by heat, and only a few moments' cooking is necessary.

"Farina," also a preparation of wheat, is less nutritious than the former, much of the gluten having been removed with the bran, but it is easily digested and in cases with a tendency to diarrhœa is preferable to any of the preparations of whole wheat.

Corn in all forms must be excluded from the dietary of scrofulous children before they reach the age of three or four years. Although its fat-forming and heat-producing powers are greater than those of any other cereal,[2] it is not easily digested, and in many cases its employment will be attended with flatulence and indigestion, perhaps terminating in diarrhœa.

Oatmeal is largely used, but as a rule is not well borne by scrofulous children, whose digestive powers are seldom strong. Still, it may be given, particularly in cases with constipation, if it is thoroughly boiled and causes no symptoms of indigestion.

Bread-jelly is useful as an occasional change from mushes, but has a tendency to constipate if given freely. It is prepared by pouring boiling water upon stale bread and allowing it to soak for an hour. The water is then removed, fresh water added, and the whole boiled until a thick mass forms. On pouring off the excess of water and cooling, a jelly-like material remains which may be eaten with milk or sugar.

Bread from twenty-four to forty-eight hours old, if properly made, is a useful food for scrofulous children. If, however, it is improperly made—that is, if the fermentation caused by the yeast has not been carried far enough, resulting in "heavy" bread,—or if it has been carried too far, causing the formation of lactic, butyric, and acetic acids —it is an exceedingly bad food. Bread made of so-called gluten flour, which, however, always contains starch, is more nutritious than that made of ordinary flour, and is generally easily digested. It is particularly useful in cases with an excessive deposit of fat.

Between the twelfth and eighteenth months, or about the time that the first four molars appear, animal food should be cautiously added to the dietary, beginning with not more than a table-spoonful of well-made beef-tea daily. Beef-tea, although it contains only small amounts of albuminoids, is an excellent introduction to the use of meat. During the first few weeks of its administration the beef-tea may be made by

[1] Made by the Health Food Company.

[2] Yeo, *Food in Health and Disease.*

the ordinary domestic process—namely, covering a pound of finely-chopped lean beef with a pint of water, and allowing it to stand in a warm place for two or three hours, and straining off the disintegrated meat. After a few weeks, however, the presence of a larger amount of soluble albuminoids is desirable, when the beef-tea should be prepared by the following method, a modification of that originally suggested by Liebig: one pound of finely-minced lean beef is macerated for one hour in a pint of water containing 15 grains of sodium chloride and 5 drops of dilute hydrochloric acid, at a temperature of 100° Fahr. The whole is then filtered through a fine sieve or through cheese-cloth, the residue being washed with half a pint of fresh water. The filtrate is transparent, has a not unpleasant taste, and contains a considerable amount of albuminoids. A child of two years may take two or three ounces of this daily, with stale bread, rice, or a well-baked mealy potato.

Adams[1] suggests as a modification of this a process by which the albuminoids are precipitated by heat. It consists of "mincing 1 pound of lean beef, and adding a pint of cold water and 10 drops of dilute hydrochloric acid. This should stand for from two to three hours, with occasional stirring. It should then be left to simmer for fifteen or twenty minutes, when it will be ready for use."

As a scrofulous child develops, larger amounts of fat should be given than in the case of robust children, care being taken not to give the fat in such large quantities as to produce indigestion. It must also be remembered that comparatively small amounts of fat produce a sense of satiety much sooner than starches and nitrogenous food, and for this reason the fat should be given at or near the end of the meal, in order that the child may take sufficient food.

A scrofulous child should not be sent to school at an early age: the confinement in a more or less constrained position, the bad ventilation, and the insufficient light of nine-tenths of our school-rooms interfere with nutrition and development. Moreover, a large proportion of school-children hurry from the breakfast-table and take little or no exercise until the middle of the day, when they eat a cold lunch and perhaps exercise to excess for half an hour. Returning home in the afternoon, they are given a warmed-over dinner, and probably at six or seven o'clock a fourth meal, which is followed by an hour or two of study. Such a routine is a most pernicious one, and in a scrofulous child is certain to lead to gastro-intestinal indigestion and deterioration of the general health, and the tissues become more and more a favorable soil for the growth of tubercle bacilli.

After the first few years of a child's life its own likes and dislikes may be consulted in selecting the most suitable food, as they are often

[1] *Cyclopædia of Diseases of Children*, vol. i. p. 338.

useful indications of what is required, provided that the stomach is in a fairly normal condition. Not that a child should be given just what it wants; but if, for instance, meat should be markedly distasteful, it should not be given in as large amounts as in the case of a child who craves meat and does not care for vegetable food. The administration of fats, however, is an exception to the rule, as they are usually disliked by scrofulous children, yet must be given in some form.

In adults the treatment of scrofulosis is based on the same general plan as that of children—namely, surrounding the patients with the best attainable hygienic conditions. All sedentary indoor occupations must be avoided, and, if possible, the patient should live in the country, either near the sea or in a dry mountainous district. The strictest precautions against exposure to cold must be observed, and the digestive tract kept in good working order. A prolonged sea-voyage is often of benefit.

The diet, as in the case of children, must contain an abundance of fat. From one to two quarts of milk should be taken daily if it does not cause constipation or that group of symptoms known as biliousness. Unfortunately, there are many cases of scrofulosis in which milk is not well borne, its ingestion for a few days causing constipation and anorexia, with a coated tongue and foul breath. These symptoms may often be avoided by taking the milk as hot as it can be swallowed without discomfort, and midway between meals, or by adding a pinch of common salt to each glass of milk. In other cases slight dilution with water will render the milk easier of digestion. Lime-water has been much used for the same purpose, and it doubtless acts, as indicated by the experiments of Meigs,[1] in causing the casein to be precipitated in the stomach as a fine curd, which can be more readily acted upon by the gastric juice than the tough, coarse curd ordinarily produced. According to Porter, two grains of inspissated ox-gall, administered shortly before the milk is taken, will render it easily digested. Many of the proprietary infant foods, while not to be recommended for the purposes intended by their manufacturers, when added to milk render it more easily digested by adults and also possess considerable food value. A table-spoonful of Mellin's or of Nestlés' food dissolved in an ounce of hot water and added to a glass of milk makes a palatable drink, and one that is more easily digested than pure milk, doubtless by causing the casein to be precipitated in a fine curd. In a few cases milk cannot be taken unless partly predigested by means of pancreatin. Raw eggs beaten up either in milk or alone with a teaspoonful of sherry constitute an easily assimilated and nutritious food. Two or three may be given daily.

Koumyss, or fermented milk, originally prepared in Russia from

[1] *Loc. cit.*, p. 72.

mare's milk, but now largely made from cow's milk, has been strongly recommended in the treatment of phthisis, and is an excellent food for the scrofulous. In the fermentation of the milk about one-half of the milk-sugar is converted into carbonic acid and alcohol, the result being an effervescent beverage with a slight cheesy taste, a liking for which is readily acquired by most persons. For the scrofulous koumyss made from cow's milk is preferable to that made from mare's milk, as the latter contains only about one-fourth as much fat as the former. True koumyss contains about 1.5 per cent. of alcohol, that made from cow's milk considerably less. Unless it is decidedly repugnant to the palate, koumyss is readily digested by the most easily disordered stomach. It is distinctly diuretic and diaphoretic.

Cream may be taken in doses of a table-spoonful two or three times daily, but frequently diminishes the appetite, and thus prevents the taking of a sufficient amount of food. It is always more easily digested if diluted with an equal amount of water or of lime-water. The addition of a small amount of sherry, brandy, or whiskey has been recommended, but in the writer's experience the addition of alcohol in any form interferes with the digestibility of cream, probably in the same way as heat—namely, by toughening the albuminoid envelope of the oil-globules. It is better to use cream as only a substitute for cod-liver oil, to be given when the latter cannot be taken. In the administration of fats their minute subdivision renders them more easily digested than if given solid. The fat of beef or mutton may be repulsive and cause indigestion if eaten in pieces, yet if thoroughly distributed through some other article of food, pulverized, as it were, it is easily taken and completely digested.

Constipation is a common and serious complication of scrofula. Constipation in itself seriously interferes with the eradication of the scrofulous diathesis, and moreover in many cases it indicates imperfect digestion from improper food. Practically, constipation is due to one of three causes—namely, improper food, ineffectual peristalsis, and deficient secretion of the intestinal juices. The cause in each case is often difficult to determine, and often can be decided upon only after therapeutic tests have been made. From whatever cause, if long continued, it interferes with nutrition and demands relief.

The removal of this complication in breast-fed infants is usually an extremely difficult problem, demanding close and patient observation. The amount of fat and albuminoids in the mother's milk must be estimated, and if either varies much from the normal the propriety of substituting bottle-feeding must be considered, the decision resting upon the presence or the absence of symptoms of indigestion. If the composition of the mother's milk is nearly normal, and yet the infant continues constipated, one bottle of slightly predigested artificial food daily

may be sufficient to cause more regular action of the bowels. In cases in which this fails the addition of "whole-wheat gluten" flour to each bottle will sometimes give excellent results. A table-spoonful should be added to a pint of water and boiled for about three hours, or until a thick custard-like paste remains. Of this a tea-spoonful may be added to the nursing-bottle just before feeding.

Oatmeal-water, often used to overcome constipation, is less efficient than gluten flour, and is much more apt to cause gastric and intestinal disorders.

Frequently, constipation in infants is relieved by giving them a few ounces of water daily. A pinch of salt given alone, and followed by a swallow of water or added to the milk, is often beneficial, particularly if flakes of undigested casein appear in the stools. Phosphate of sodium, in doses of from 10 to 20 grains daily, given in the child's milk, is efficient in all cases; it is in case of slight intestinal catarrh, however, in which it is most useful. Sugar, molasses, and honey, each of which has been recommended, must not be given to infants under a year old, for an excess of sugar is certain to cause acid fermentation, perhaps followed by diarrhœa, and then by aggravation of the constipation. In older children bread and molasses (not *syrup*) may be given each day, provided that there are no symptoms of gastric indigestion. Constipation in the scrofulous is almost invariably relieved, and often cured, by the use of cod-liver oil.

Suppositories of cacao butter, given once daily for a month or two, are useful in not very obstinate cases of constipation due to atony of the lower bowel. They act probably by exciting the smooth muscular fibres of the lower bowel to contraction, which, as in other parts of the body, results in increase of muscular power, and by lubricating the fæces and permitting them to pass with less resistance. In obstinate cases gluten suppositories are much more efficient. Glycerin suppositories should be used only to relieve acute constipation or in chronic cases when it becomes absolutely necessary to open the bowels. The same may be said of glycerin enemata. The daily adminstration of an enema of tepid water has been recommended by Jacobi and others, and may be resorted to if the foregoing measures fail.

Massage of the abdomen is an important part of the treatment of constipation in the scrofulous. In infants it can seldom be carried out properly, but even if imperfectly performed it is of service, and should be systematically employed. The movements should consist chiefly of deep kneading and sharp tapping, beginning over the cæcum and following the course of the large intestine, continued for ten minutes at a time twice daily. Electricity, also not well adapted to the treatment of infants, is a valuable therapeutic agent in the treatment of constipation from intestinal atony in adults. (For the details of

its application the reader is referred to the preceding article on Electricity.)

Drugs specifically directed to the relief of constipation in scrofulosis are of little use, except in that form caused by lack of power of the smooth muscular fibres of the intestine, but in the latter form nux vomica or its alkaloid, strychnine, is invaluable, but must be given in full doses and persistently. Our own preference is for the sulphate of strychnine. A child of six months may take from $\frac{1}{300}$ to $\frac{1}{200}$ grain three times daily; a child of one year may take $\frac{1}{150}$ grain. In older children and adults the dose should be carefully increased until there is distinct exaggeration of the knee-jerk, when it may be slightly reduced and given for several months. In children between ten and fifteen years of age the proper dose will be between $\frac{1}{60}$ and $\frac{1}{30}$ grain; in adults even as much as $\frac{1}{12}$ grain may be required.

Medicinal Treatment.

Cod-liver Oil.—First in the list of medicinal agents for the elimination of the scrofulous diathesis must be placed cod-liver oil, partly a food and partly an alterative, depending for its properties not only upon the fact that it is an oil, but upon the combination of substances which it contains. De Jongh's analysis of cod-liver oil showed the presence of glycerin, oleic, margaric, butyric, and acetic acids, biliary principles, iodine, chlorine, traces of bromine and phosphorus, and a peculiar substance termed *gaduin*. The value of the oil in scrofulous affections has been attributed to the iodine, but there is rarely more than 1 part of this element in 2000 parts of oil, and from the light-colored oil it is often absent. Gaduin is apparently inert, and each of the remaining substances is present in too small amount to be therapeutically active. The experiments of Naumann some years ago proved that cod-liver oil passes through animal membranes, both living and dead, more rapidly than any other oil, the experimenter attributing this peculiarity to the presence of the biliary principles. Other experimenters have confirmed the accuracy of these observations. Still others have asserted that cholesterin is the only biliary principle present in cod-liver oil, and Brüke's experiments apparently show that the ready diffusibility of the oil is due to the presence of fatty acids. Careful experiments have also shown that cod-liver oil is very easily oxidized.

The remarkable nutritive and alterative properties of cod-liver oil, then, are almost certainly dependent upon the ease with which it is absorbed and oxidized, and upon the combination of substances which it contains.

It is in the treatment of scrofulosis and the early stage of tubercu-

losis that the effects of cod-liver oil are the most manifest, but to obtain good results it must be given carefully, the amount and the method of prescribing being suited to the condition of the patient's digestion. It is worse than useless to give half an ounce when but half a drachm can be assimilated.

To cases with well-marked scrofulous diathesis, but with no evidences of tubercular involvement, the persistent administration of cod-liver oil, if the hygienic surroundings of the patient are good, will almost certainly result in complete eradication of the tendency to tuberculosis. In scrofulous ophthalmias and skin lesions the results of the use of cod-liver oil, combined with appropriate local treatment, are often brilliant. In enlargement of the lymph-glands and tonsils the oil should be given, although its direct influence upon the diseased structures is seldom very distinct. In such cases it is given more with the object of increasing nutrition and preventing further complications than to cure the lesions that may be present. In the protracted acute bronchitis of the scrofulous, cod-liver oil is by far the most valuable remedy we possess, and even in the earlier stages, while the cough is still tight, it often acts as a soothing expectorant, and may be used if the temperature is not elevated and the stomach is not irritable. It is also valuable in all stages of rhinitis common to scrofulous persons.

Cod-liver oil is much used in the treatment of caries and necrosis of bone in the scrofulous, but in these diseases it has seemed to the writer to be of little use. In severe cases there is always more or less fever, the stomach is irritable, and diarrhœa is not infrequent, any one of which interferes with the action of the oil. If given at all, it should be in small doses with wine or spirits, withholding it if the tongue becomes coated, if there is nausea or diarrhœa, or if there is failure of the appetite.

The dark-brown or black "Straits" oil was formerly used in preference to the less offensive "shore" oil, De Jongh particularly advocating it on account of the supposed larger amount of biliary principles, and because he believed that the products of decomposition greatly increased its therapeutic value. Whatever its advantages, however, they are more than outweighed by its taste and smell, which are so very offensive that few people are willing to take the crude oil, or, taking it, can assimilate it.

Both the light-colored and dark-colored oils are adulterated and imitated, but to what extent it is impossible to determine. A German writer has asserted, on what authority we know not, that in America a spurious cod-liver oil is made by macerating herring in olive or cotton-seed oil—for a few hours if a light-colored oil is desired, longer if

a dark-colored. Whether this be true or not, cod-liver oil should be obtained from a reliable manufacturer.

According to the U. S. Dispensatory, the most certain test for the purity of oil is the presence of an odor resembling that of shoe-leather. Absence of the biliary colors on adding a strong acid proves that the specimen is not cod-liver oil, but the presence of the colors merely shows that the oil contains biliary principles and is no test of purity.

The administration of cod-liver oil is nearly always attended with difficulty at first, and great care must be exercised or the disgust may become unconquerable. In cases in which the repugnance is great it is well to begin with very small doses—from ten to twenty drops three times daily—until the patient becomes somewhat accustomed to the taste. The amount may then be gradually increased until within a month a dessert-spoonful is taken at a time. It is seldom advisable to give more than a table-spoonful three times daily, as more than this is not absorbed, and is almost certain to interfere with digestion. In some cases no more than a tea-spoonful can be given without diminishing the appetite and producing eructations of gas tasting and smelling of the oil. A few cases, however, will be found which acquire a liking for the oil, and can take two or three ounces daily without evidences of gastric derangement and with benefit. It is usually best given about an hour after eating, when it is emulsified with the food and is then easily absorbed. In some cases it is better tolerated if given in a single dose at bedtime.

Many methods of masking the taste of cod-liver oil have been devised. In adults, if alcohol is indicated, the oil may be floated on ale or beer, covered with froth and swallowed quickly, the taste of the oil not being perceived. It may also be floated on whiskey and water, strong coffee, or lemon-juice, and quickly gulped down. The taste is scarcely noticeable if just before taking the dose the mouth is washed out with undiluted whiskey or brandy containing two or three drops of oil of peppermint. The same effect is obtained by holding a peppermint lozenge in the mouth just before taking the oil, and with children this method is usually successful. Common salt may be used for the same purpose, but is less efficient. In several instances the writer has been able to give the oil by requiring the patient to hold a $\frac{1}{2}$ per cent. solution of cocaine hydrochlorate in the mouth for a few moments previously.

Emulsions of cod-liver oil are largely used, and on theoretical grounds are believed by some to be more readily absorbed and less likely to disagree than the pure oil; but practically better results are obtained by administering the pure oil. One reason for this is doubtless that it is difficult to make an emulsion containing more than 50 per cent. of oil, and patients are seldom willing to take the necessarily

larger dose. There are a few persons, however, who seem unable to take the oil in any other form, and in such cases it is better to use an extemporaneously prepared emulsion than those that are prepared in large quantities, for cod-liver oil deteriorates with age, and mixtures made by the wholesale are likely to be a year or more old before reaching the consumer. The oil is best emulsified either with mucilage of tragacanth or with yolk of egg and glycerin. The following are formulæ of excellent emulsions:

℞. Cod-liver oil,	6 ounces;
Oil of wintergreen,	1 drachm;
Mucilage of tragacanth,	2 ounces;
Orange-flower water, sufficient to make	12 ounces.

Any agreeable essential oil may be used in place of the oil of wintergreen, and if for children it is well to add two or three drachms of sugar.

℞. Cod-liver oil,	6 ounces;
Oil of wintergreen,	1 drachm;
Chloroform,	2 drachms;
Glycerin,	
Yolk of egg, of each	5 drachms;
Orange-flower water, sufficient to make	12 ounces.

The second mixture is not so thick as the first, and is for that reason preferred by some.

The so-called pancreatized emulsions as sold in the shops are unsatisfactory in practice, but it is said that two ounces of finely-chopped pancreas added to a gallon of oil, thoroughly mixed and strained off, makes an excellent emulsion. An emulsion may also be made by thoroughly mixing equal parts of cod-liver oil and a thick extract of malt, such as "maltine."

Lefaki[1] gives the oil emulsified with an equal quantity of lime-water and flavored with lemon syrup, vanilla, or anything desired by the patient. The mixture is permanent and readily assimilated, and, it is said, may be given even if there is diarrhœa.

The following is Carlo Pavasi's method of masking the taste of the oil: 1000 parts of cod-liver oil, 50 parts of ground coffee, and 25 parts of animal charcoal are placed in a flask and heated for an hour over a water-bath. The mixture is then set aside in a cool place, and stirred occasionally for three days, when the oil is filtered off and is ready for use. A cod-liver oil jelly may be prepared by means of

[1] *Journal de Méd. et de Chirurgie*, May, 1889.

isinglass, but is not very palatable. Oil of bitter almonds added in the proportion of three drops to the ounce masks the taste of cod-liver oil very thoroughly.

In cases in which administration of the oil by the mouth must be abandoned inunctions may be resorted to, and from them well-marked therapeutic effects can be obtained. A drachm previously warmed, should be poured into the palm of the hand, and well rubbed into the skin of the abdomen and the inner side of the thighs. From two to four drachms may be thus used at a time, rubbing for about five minutes for each drachm of oil. H. A. Hare[1] asserts that if a small quantity of bile-salts be added to the oil absorption by the skin is much more rapid.

Von Mering,[2] acting on the hypothesis that the virtues of cod-liver oil depend upon its ready diffusibility and emulsification, due to the presence of free fatty acids, proposed as a substitute free from unpleasant smell and taste olive oil to which has been added 5 per cent. of oleic acid. This he terms *lipanin*, and claims that large quantities of it may be given without deranging the stomach or intestines, and with rapid deposition of fat and improvement in health in those who are emaciated from disease. Hauser[3] and a few others have also reported good effects from the use of lipanin, and, although it has not come into general use, it is worthy of trial in cases in which cod-liver oil is not well borne. Hauser gives it in doses of from one to three tea-spoonfuls three times daily, after meals, and finds that it causes rapid gain in weight. That the lipanin is absorbed is shown by the very small quantity of fat and fatty acids that can be recovered from the stools.

Iodine, either alone or in combination, has been used in the treatment of scrofulosis, and more particularly in the treatment of glandular enlargements, for many years, and it is certainly a valuable remedy in cases of enlarged lymph-glands if they are not acutely inflamed and if they have not undergone cheesy degeneration. Bartholow writes that "the preparations of iodine are effective only when simple hypertrophy of the lymphatic glands has taken place; if they have undergone caseation or have proceeded to suppurate, no medicine has any influence over them." There is no clinical evidence to prove that any drug has the slightest specific effect in causing absorption of cheesy masses, but that iodine causes reduction in size of cirrhotic or infiltrated glands is certain; and, moreover, it has a specific effect upon the scrofulous diathesis, occasionally as marked as its effect upon tertiary syphilis.

In the inflammations of the skin of the scrofulous iodine is often serviceable, its value usually being proportionate to the chronicity of

[1] *Therapeutics*, 2d edition, Philadelphia, 1891.
[2] *Therapeutische Monatshefte*, February, 1888.
[3] *Zeit. f. klinische Med.*, Bd. ix., 1888.

the affection. Eczema in its earlier stages will be almost certainly aggravated by the use of iodine.

In scrofulous rhinitis and ophthalmia and in some cases of hypertrophied tonsils it is a valuable remedy, but in these conditions also acute symptoms contraindicate its use.

Either iodine itself or potassium iodide is preferable in the rather exceptional cases of scrofulosis without anæmia, while the iodide of iron should be used in cases of anæmia.

The tincture of iodine should never be administered by the mouth, as the iodine is precipitated on reaching the stomach and causes indigestion and pain. The only eligible preparation of pure iodine to administer is Lugol's solution or the *Liquor Iodi Compositus* of the U. S. Pharmacopœia, of which twenty drops contain one grain of iodine and two of potassium iodide. To children one drop of this, well diluted, may be given three times daily, rapidly increasing, if it is well borne, to five drops. More than this it is seldom advisable to give. Adults may begin with five drops, and increase to twenty, three times daily. Milk is a good vehicle in which to administer the solution, a glassful being only slightly flavored by five drops of the solution. As with any other preparation of iodine, the slightest evidence of gastric derangement is an indication for the immediate temporary withdrawal of the remedy.

Syrup of the iodide of iron is more used, and probably more useful, in the treatment of scrofulosis than is any other preparation of iodine. Its indiscriminate employment is, however, often productive of disastrous gastric derangements. It is suited to those cases in which there is well-marked anæmia—the majority of cases. It must be given in small doses and for a long time, and discontinued whenever it is not well borne by the stomach. The best time to take it is about two hours after meals, when the process of digestion is far advanced, but the stomach not yet empty. To children not more than from 3 to 5 drops should be given at the outset, slowly increasing to from 10 to 12 drops. Adults can take proportionately larger doses.

Phosphorus has been recommended in the treatment of scrofulosis, chiefly by Jacobi, who believes that he has seen much benefit from it. "Scrofulous tissues," he writes, "with their rapid decay and new formations have indeed the characteristics of cell-proliferation, which perishes speedily because it is not sustained by a healthy connective tissue. The latter is formed by the internal administration of minute doses of phosphorus." Phosphorus is certainly of some value in the treatment of scrofulosis, but holds a secondary place to iodine and the iodides. It may be prescribed in the form of the 1 per cent. *Oleum phosphoratum* of the Pharmacopœia, beginning with from one-half to one drop, according to the age of the patient. Cod-

liver oil is usually indicated in cases to which phosphorus is given, and makes a good vehicle in which to administer it.

The *phosphates* have been recommended in the treatment of scrofulosis, particularly by Beneke, on the ground that in many cases of scrofulosis there is an excess of phosphates in the urine, indicating a waste that should be artificially supplied. The reasoning is perhaps not entirely logical, but phosphates are often used in scrofulosis, and sometimes apparently increase general nutritive activity.

Phosphate of calcium is particularly useful in cases of suppurating scrofulous ulcers, and in such cases should be given in doses of from one to three grains three times daily. Larger doses are unnecessary, as only small amounts are absorbed; and, indeed, Ringer suggests that large doses might be dangerous, as the salt is unaffected by the intestinal secretions, and hence liable to form concretions. Owing to its more ready solubility, the lactophosphate of calcium is a better preparation to use than the simple phosphate. The syrup may be combined with cod-liver oil and the syrup of the iodide of iron as follows:

℞.	Syrup of iodide of iron,	1 drachm;
	Cod-liver oil,	1 ounce;
	Syrup of lactophosphate of lime,	1 ounce;
	Lime-water, sufficient to make	4 ounces.

Dose, from one to four tea-spoonfuls. To be well shaken.

Chloride of calcium was formerly extensively prescribed in the treatment of scrofulous gland disease, and its use has lately been revived by Mays,[1] who thinks it valuable in cases of "pale rickety children who have swollen cervical glands, poor appetite, coated tongue, and constipation, and in whom there is a general indication of malassimilation." In the "glandular swellings of adults," a somewhat vague term, he thinks that the resolvent powers are marked, although in such cases it requires a longer time, "and its action is facilitated by the simultaneous application of iodine." Coghill writes still more enthusiastically of the drug, and has seen "chronically enlarged and indurated glands which absolutely amounted to deformity, and which had resisted all previous treatment, yield, even in adults, to the administration of this salt." It may be given in doses of from 2 to 20 grains, according to the age of the patient, and, as its administration must be prolonged, water is a better vehicle than syrup, which tends to produce acid dyspepsia.

Sulphide of calcium is strongly recommended by Ringer in the treatment of suppurating cervical glands, on the ground that it hastens the elimination of the pus and cheesy deposits. After the abscesses

[1] *Arch. of Pediatrics*, August, 1888.

have opened and are discharging a small amount of unhealthy pus, the edges of the ulcer being indurated, Ringer thinks that sulphide of calcium "renders the discharge more abundant, thick, creamy, and healthy, considerably hastens the evacuation of the scrofulous matter which prevents the healing of the wound, and at the same time softens the round indurated edges, so that the sore heals much more quickly." In long-standing cases the drug must be administered for several weeks before the effects become manifest. In the writer's experience sulphide of calcium has proved a valuable adjunct in the treatment of suppurating scrofulous glands. In children it is best to begin with from $\frac{1}{20}$ to $\frac{1}{15}$ grain, increasing to $\frac{1}{10}$ or even $\frac{1}{5}$ grain. Adults may take at the outset $\frac{1}{4}$ grain, increasing to $\frac{1}{2}$ grain, Ringer giving in some cases as much as 1 grain. It may be prescribed in gelatin capsules, in solution, or in the form of powder. The most convenient and satisfactory method is to prescribe it in powders, each of which should be dissolved in a glassful of water just before it is taken. It cannot be kept long in solution, as the sulphide is rapidly oxidized. In solution the taste is simply that of an ordinary sulphurous mineral water.

Anæmia is frequently associated with scrofulosis, and, as elsewhere, is an indication for the administration of iron. If there are glandular enlargements, nasal catarrh, or suppurative otitis media, syrup of the iodide is generally the best form in which to administer iron; but if merely the scrofulous diathesis is present, without distinct lesions, iodine is not required, and some other preparation of iron should be used, that being given which causes the least gastric disturbance and constipation. This is not the place to discuss the merits of the different compounds of iron, each one of which will be sometimes found to be the best in certain cases.

Alcohol must be used with great care in the treatment of scrofulosis, as in other long-continued conditions, and should not be given at all unless there are complications demanding it. The only indications for it are suppuration or tubercular inflammation, with fever and general symptoms more or less resembling hectic. These being present, small doses of well-diluted spirits should be given daily.

Quinine is indicated by the same conditions which require alcohol, and should also be given in cases which seem to have arisen from malarial poison, as well as in those complicated by intermittent fever.

Arsenic has been used with asserted success in the treatment of scrofulosis, but it is difficult to understand what effects it should have, and it is not improbable that the successful cases in which it was used were those in which malarial poisoning was the cause of the scrofula.

The remaining remedies which have been used as specifics require only mention. They are pipsissewa, stillingia, sarsaparilla, sanguinaria, potassium chlorate, the salts of barium, and mercury.

Treatment of Scrofulous Glands.—The treatment of scrofulous disease of the lymph-glands may be considered under two heads—namely, medicinal, including external applications, and surgical. The general medicinal treatment of enlarged glands does not differ materially from that employed in the treatment of the diathesis itself, and is elsewhere considered in this article.

External applications have been, and doubtless always will be, largely used. Good effects are obtained from them in cases which have not advanced to caseation, but it is doubtful if they ever reduce to any extent caseated glands. *Tincture of iodine*, a time-honored application, is useful chiefly in subduing acute inflammation. It should be painted over a surface considerably larger than the swelling, but it should not be used so frequently as to cause marked irritation of the skin, else a new focus of inflammation is excited which may be followed by tumefaction of other glands. In children, and in adults in whom the skin is easily irritated, an ointment consisting of iodine 20 grains, iodide of potassium 5 grains, and lanolin 1 ounce is preferable to the tincture of iodine; it causes less local irritation, and probably sufficient iodine is absorbed from it to exert a specific action upon the disease.

Ichthyol has been strongly recommended by some surgeons in the treatment of glandular disease, but in a number of cases of both acute and chronic glandular enlargement in which the writer has used the drug no effects could be observed, and he cannot but think that its efficacy has been exaggerated. It may be used in the form of an ointment, with either lanolin or vaseline as a base, beginning with a strength of 5 per cent., and increasing to from 10 to 15 per cent. if it does not cause redness of the skin.

Emplastrum ammoniaci, and *emplastrum ammoniaci cum hydrargyro* containing sulphur and mercury, will sometimes cause reduction in the size of recently enlarged glands. The latter must not be used for long periods of time, as it may produce mercurial poisoning. The ointment of the iodide of lead is also a good application in recent cases. The injection of various substances into the glandular enlargements has been practised to a limited extent, but has nothing to commend it, and we are entirely in accord with Mr. Treves, who writes that it is an "uncertain and dangerous proceeding, especially for glands which are deeply seated."

In many cases marked reduction in the size of scrofulous glands may be secured by keeping the parts at rest, but this method of treatment is applicable only to cervical glands. In this region rest of the parts may be secured by wearing a wooden stock or collar or by the use of the splint devised by Mr. Frederick Treves, which consists of an upright attached to the back by means of chest- and waist-bands

and a band passing around the forehead. To be of use rest secured in this manner must be persisted in for some weeks.

Should constitutional treatment and rest of the affected region fail to cause considerable reduction in the size of the tumors, surgical treatment must be considered, as the tubercular tissue may infect the system, and will certainly prevent elimination of the scrofulous diathesis.

Two operations are available—namely, erasion or scooping, and excision. Erasion is preferable in cases in which only one or two glands are affected, but should not be undertaken if a number of glands are involved. It is performed by making a small incision through the capsule of the caseous mass, inserting a Volkmann's spoon, and thoroughly scraping away all softened tissue, the whole of course being done under antiseptic precautions. The parts should be kept rigidly at rest until cicatrization is nearly complete. Scraping is also applicable to cases with fistulæ leading to old glandular abscesses and to ulcers with thickened unhealthy bases and ragged edges. The operation has been objected to by Mr. W. Knight Treves,[1] on the grounds that it leaves an abscess-cavity, and that by this means it is difficult to remove all the diseased tissue. These objections hold in many cases, but if it is restricted to those in which only one or two superficial and softened glands exist, the operation is a proper one and is much less formidable than excision.

In cases with masses of caseated glands excision is the only operation that gives good results. The procedure is one requiring patience and care rather than special surgical skill. "The cardinal secret of success in these operations is to keep on the tumor—that is, to cut with the knife or to scratch with the grooved director through the bands of connective tissue which hold the gland down to the neighboring parts, doing this cutting and scratching directly upon the glands themselves at safe limits from the edge nearest to important structures."[2] If these directions are carefully followed, enormous masses, with prolongations extending into the supraclavicular fossa and surrounding the blood-vessels and nerves of the neck, can be safely removed. Cicatrization goes on with rapidity if the operation has been complete, if antisepsis has been perfect, and if the parts are kept at complete rest after the operation.

[1] *Lancet*, October 5, 1889.

[2] J. William White, *Therapeutic Gazette*, April 15, 1890.

SCURVY, OR SCORBUTUS.

By CHARLES EDWARD BANKS, M. D.

Scurvy is a systemic disease, marked by chronicity rather than acuteness in respect to course, resulting from the omission of certain necessary food-constituents rather than a deprivation of all, or from the consumption of an improper diet, and characterized by anæmia (secondary), hemorrhages into the skin and deeper structures, progressive debility and emaciation, and spongy or ulcerating gums. It may be due to a specific infection; but if so, the pathogenic microörganism has not yet been isolated.

It would not be profitable to enter into an extended survey of this disease as described by the ancient fathers of medicine, for it has undoubtedly been recognized by them from the earliest times. If we may translate into modern tongue the fanciful descriptions of disease recorded by those apostles of the profession to whom we render all homage due to pioneers, we may discern references to clinical symptoms that might be called scorbutic, as in Hippocrates on "Airs, Waters, and Places" and on "Prorrhetics." Pliny and Strabo both give satisfactory descriptions of scurvy as it appeared in the campaigns of Cæsar Germanicus and Aëllius Gallus, respectively. Beginning with the period of geographical explorations in the fifteenth century, which involved long absences in unknown seas, in search of the wealth of Ind and for the "Northwest Passage" to the realms of Cathay, the experiences of those great discoverers, recording their celebrated voyages over the then unknown waters of the globe, always included tales of suffering and death from the disease known as scurvy. Pierre Quirino, Vasco de Gama, and Jacques Cartier all certify to the fearful ravages of scorbutus among the seamen under them. As late as the last century Anson lost more than four-fifths of his men while circumnavigating the globe. From these circumstances it naturally came to be considered a disease peculiar to those "who go down to the sea in ships, and have their business in great waters," and it was not till many years after that medical authorities considered it as existing on shore. A "sea scurvy" and a "land scurvy" were described by later writers (Pringle); and as knowledge of clinical conditions advanced it found expression in a more intelligent and detailed description of the constitutional disturbances in scurvy as seen both on land and sea. As a result of

the researches of Lind and others in the early part of this century, it has ceased to exist in the naval services of any nation; and from the application of the same rules in the merchant service the appearance of it, except under extraordinary circumstances, is reduced to a well-deserved minimum. Indeed, it is unquestionably more common on land than on the sea. In the Civil War, 1861–65, among the white troops, during the five years covered by the statistics, 30,714 cases of scurvy were reported, and 383 deaths directly attributed to the disease. It was the opinion of the editors of the *Medical History of the War of the Rebellion* that many cases entered as "general debility" were in reality scurvy. The record of our soldiers was an improvement over the experience of the French army in the Crimea. Scurvy was one of the many sad accompaniments of the siege of Paris.

Scurvy is a disease of occupation and diet. It exists in what may be called either epidemic or endemic form, whenever an individual or a body of individuals subsist for a prolonged period on a diet in which fresh vegetables or a succedaneum are lacking, and this condition, when aggravated by unsanitary surroundings, is relatively accelerated. Just what constituents in fresh vegetables must of necessity be supplied to the economy is not entirely understood, but that the lack of this element is the primal predisposing cause is now admitted by all authorities. It naturally follows that individual conditions—physical, mental, and moral—also act as determining factors. The weak and feeble, particularly children, succumb readily, as well as those debilitated by previously existing or concurrent diseases. In prisons and almshouses, where the surroundings tend to mental depression, the inmates easily become scorbutic, especially if the proper dietetic conditions have not been observed. Retreating armies, suffering not only from fatigue incident to war, but from the disgrace of defeat, are notable instances of those who yield readily from collateral effects combined with improper diet. In fact, anything of a physical, mental, or moral nature which contributes to the lowering of the vitality below "concert pitch," not forgetting even homesickness, is a contributory predisposing cause if the essential conditions respecting diet are present.

While scurvy is a disease of occupation, it is neither a disease of country, race, sex, age, nor season. It naturally prevails in those countries and among those races whose observances of hygienic laws are "more honored in the breach," but it has its victims among the most civilized peoples.

Males probably contribute a greater proportion to the statistical tables, for the evident reason that they are more usually subjected to the conditions of dietary omissions, hardships, and anxiety than females. Otherwise the problem of sex is an unimportant factor in the etiology of this disease.

In the matter of age, it is met with from infancy to dotage. A case of scurvy was recently reported (1899) in an infant of six weeks. The child had always suckled at the breast, but the milk was decidedly inferior in quality (Crandall). Institutions for the aged furnish cases occasionally, mostly sporadic; but it can be said that scurvy is a disease of adult life rather than of the extremes of age.

Probably the winter season adds to the number of cases in those countries where the disease exists in epidemic or endemic form, as in Russia. This is due to an aggravation of the unsanitary situation from the herding of individuals in unventilated hovels, the inclement meteorological conditions, and the relative as well as actual scarcity of vegetables at that season. In like manner it has been shown that years marked by extreme rigor have produced more cases of the disease. But these factors of demography, nationality, sex, age, and climate are of only minor contributory importance, and need not further claim consideration.

In the matter of occupation, the avocation of mariner was preëminently the one calling that claimed the most victims, until the attention of those intimately concerned in maritime affairs was directed by Lind and others to the main cause of the disease. It is still the occupation which is most liable to the appearance of the disease among its followers, notwithstanding the statutory requirements existing in all civilized countries concerning seamen's rations. The experience of the Marine-Hospital Service of the United States, whose function is, in part, to care for sick and disabled American seamen, affords the only index to its prevalence among the merchant sailors of this country, as well as those few of other flags who are treated in our marine hospitals; and from its statistics, compiled for a period of twenty-seven years (1872 to 1898, inclusive), the following tables have been constructed to show the yearly number of cases treated and the gradual decrease in late years:

Cases of Scurvy Treated in U. S. Marine Hospitals and Dispensaries from 1872 to 1898, inclusive.

Year.	No. of Cases of Scurvy.	All Diseases Treated.	Year.	No. of Cases of Scurvy.	All Diseases Treated.
1872	18	13,156	1888	17	48,203
1873	47	13,529	1889	32	49,518
1874	59	14,356	1890	28	50,671
1875	25	15,009	1891	32	52,992
1876–77	89	31,983	1892	30	53,610
1878–79	24	39,155	1893	34	53,317
1880	39	24,860	1894	27	52,803
1881	42	32,613	1895	14	52,643
1882	55	36,184	1896	24	53,804
1883	43	40,195	1897	20	54,477
1884	27	44,761	1898	6	52,709
1885	34	41,714		—	———
1886	18	43,822		821	1,011,398
1887	37	45,314			

This is less than 1 per 1000 for the time stated. Dividing the twenty-seven years into three periods of nine years each, the following result is obtained:

1872–1880	301 cases.
1881–1889	305 "
1890–1898	215 "

It should be said in explanation of these tables that about half of the cases of scurvy reported occurred on the Pacific Coast, principally at San Francisco, where the writer had an opportunity, while on duty at that port, to examine and treat about seventy-five cases in the course of three years. These cases occur usually on vessels sailing around the "Horn" from England, or elsewhere, in which the long voyage is partly accountable for the appearance of the disease among the crew. These vessels are known as "lime-juicers" among sailors, by reason of the requirements for carrying lime-juice as a prophylactic. It is also to be said that but few cases occur on American vessels, and those from accidental circumstances due to an unexpected long voyage, detention by inclement weather, or shipwreck.

In the matter of diet, the old proverb that "Variety is the spice of life," holds particularly true in respect to scurvy. The proximate adherence to the normal proportions of carbohydrates, proteids, and fats must be the one condition that prevents the appearance of scurvy in man. Any continuous omissions from this varied régime, especially in the elements contributed by fresh vegetables, will lead to scorbutic conditions. And this may obtain although the other elements be sufficient in amount, or even in excess, for it is not quantity nor quality, but variety that is the determining agency in the alimentation of mankind. The improper preparation of food for consumption may have but little influence, although if other conditions are present it may add its weight to the causative factors. The late Surgeon-General Hamilton, in his article on "Scurvy," in a previous edition of this work (page 1004) says: "In logging camps, camps of charcoal-burners, and the like, where the diet consists almost exclusively of molasses, bread, and bacon, the writer has seen cases of scurvy; and even in farming regions, where vegetables are plentiful, cases of scurvy not infrequently appear, due to voluntarily restricted diet and neglect of the most ordinary precautions."

Example of this latter condition is found in a case admitted to the Johns Hopkins Hospital, in which the patient, a woman, had subsisted for many months on tea and bread (Osler).

An excess in the consumption of one of the natural orders which supply man with nutrition, provided there be a lack of the vegetable element, will produce scurvy; but abstention from all food will not

induce scorbutic symptoms. Prolonged starvation, either designed or involuntary, in itself does not necessarily produce the characteristic conditions. None of the professional "fasters" of late years has shown any of the symptoms of scurvy.

The question of a specific pathogenic microörganism has engaged the attention of several observers (Uskow, Rosenell, Babes, and others); but the evidence of the existence of such an infectious agent has not yet been forthcoming, at least to a degree that might even be called probable. That the disease occurs in epidemic form on shipboard or in armies is not convincing, as it is easily shown how other well-established conditions affect the victims. Purpuric lesions have followed the injection of animals with the blood of scorbutic patients; but this may be associated with septicæmia (Murri, Cantu). A microörganism, described as a long, slender bacillus, was found by Babes in the superficial and deep tissues of the gums of patients suffering from scurvy; and animals injected with the pure culture succumbed with some of the signs of serous and cutaneous hemorrhages. Although this observer actively champions the infectious theory, it must be said that satisfactory proof is wanting besides his ingenious theories regarding an oral parasite which had been previously described by Müller. As has been said by a recent writer, "Even though the disease should prove to be infectious, it would remain certain that unsanitary surroundings and improper diet are factors of the greatest importance in preparing a suitable soil for the occurrence of scurvy."

There is nothing characteristic in the anatomical changes which occur after death from scurvy, though the appearances are generally constant. Cutaneous ecchymoses and local hemorrhagic infiltrations of the internal organs are usually noted at necropsies in these cases. There are hemorrhagic foci in the muscles of the lower extremity and about the joints, and hemorrhages on the serous membranes and into the kidneys and bladder, and among the more common appearances are hemorrhages into the mucous membranes. Some of these conditions were in evidence during the course of the disease, and are merely the remains of a previous clinical condition.

There are serous effusions into the pleura and pericardium, the cavity of the latter less frequently so, while the peritoneum is not affected in this manner.

The internal organs, as a rule, show constant parenchymatous degeneration in addition to hemorrhagic suffusions into the tissues. No inflammatory or suppurative processes have been observed except in the lungs, where pneumonia is sometimes the intercurrent cause of death.

The condition of the first portion of the digestive tract may be

said to be the most characteristic and most nearly specific. Reference is here made to the mucous membrane of the buccal cavity, which shows the proliferative and ulcerative changes observed in the course of the disease. They will be described fully under the discussion of symptoms, and need not be repeated here. Microscopical examination of the tissues forming the gums shows degenerative changes of the superficial epithelium, with proliferation of the deeper connective tissues. Uskow has described endothelial proliferative changes in the lumen of the bloodvessels supplying the gums to the extent of obstructing the lumen. The stomach and intestines present the hemorrhagic patches common throughout the body, and occasionally ulcers are found in the ileum and colon, though general ulcerative changes in the tract rarely exist. The spleen is soft and quite constantly enlarged.

In a case which died in the Marine Hospital, New York, in 1883, blood oozed from the incisions on the cadaver almost as rapidly as from a living subject; the pleural cavities and pericardium contained a bloody effusion; both ventricles were full of fluid blood, and there was bloody fluid in the large bronchi (Hamilton).

Symptoms and Clinical Course.—The course of scurvy from its onset to the termination is marked by a slow and steadily progressing upward and downward curve. There is no sudden attack nor clinical crisis. The approach is without warning unless the patient is under conditions familiarly known to him, as in the case of seamen on a long voyage without antiscorbutic prophylactics. The usual prodromal symptoms of decreasing strength, pallor, loss of appetite and weight, with possibly some gastro-intestinal disorder, constitute the early clinical features of the disease. Sometimes there is a premonitory sore throat catarrhal in type. This condition under favoring circumstances becomes established, and further manifestations of progressive anæmia attract the eye. The skin is dry and desquamative, and shows a hue which may be called dirty for want of a more applicable term; and this earthy pallor, increasing with the progress and severity of the disease, is soon accompanied by pinching of the features, inexpressive dulness of the eyes, and orbital sinkings. The patient takes to his bed, complaining of pain in the lower extremities, and shows thoracic oppression and palpitation.

Following this, as a rule, the characteristic scorbutic symptom —swelling of the gums—appears, although it may not take place until later in the course. It is, however, one of the early manifestations, and begins near the median line at the dental margin of the gum surrounding the incisor teeth, and in the salient parts between the teeth, from which it spreads to the surrounding tissues. The gums show at first a reddish border, which increases in area as the superficial mucous

and deeper connective tissues become involved in the tumefaction. A spongy condition ensues, and bleeding upon the slightest touch, during mastication of food, or even from movements of the tongue. This proliferative growth of the gum tissues, resembling the surface of a cauliflower in pronounced cases, and having a soggy feel, soon rises above the neck of the teeth, and may in time completely cover them. During the development of this process there is usually an increased flow of saliva, dependent sometimes upon an enlargement of the salivary glands, indicative of a mild septicæmia, and the breath becomes intensely fetid. The tongue is usually coated and somewhat swollen, interfering with mastication and articulation; and when to this is added the dribbling of sanious saliva in advanced cases the revolting facies of scurvy is complete.

This tumefaction of the gums may proceed to superficial ulcers, and even necroses of the deeper tissues, which result in eschars; or it may so affect the integrity of the gums about the neck of the teeth that detachment occurs with loosening of the teeth, and sometimes dislodgement follows. This is usually confined to the incisors, which are mostly used in the process of mastication. Eating of food is necessarily, under these conditions, not only a painful but a disagreeable function, and the sufferer seeks, if possible, the nourishment of liquids in preference to solids.

The young (before the eruption of the teeth) and the aged (who have lost them) do not appear to have this tumefaction of the gums to any extent during the course of scurvy. It is, however, more likely to exist in the young than in the old. A case recently reported indicates this possibility in infantile scurvy.

The second characteristic symptom of scurvy is the hemorrhagic suffusion into the cutaneous, mucous, and deeper tissues; and it is usually synchronous with the development of the gum symptoms or is later in appearance. These spontaneous hemorrhages under the skin are to be seen at first in the lower extremities, and show themselves as dark-red petechial macules, varying in size from the smallest punctate form, most of them with a hair-follicle in the centre. These suffusions are connected in some way with the tissues surrounding the sebaceous glands and hair-follicles, and as they become more pronounced in size may coalesce with adjacent hemorrhages and form larger patches. While these hemorrhages are spontaneous, they may be excited by blows or other injuries upon the cutaneous surface, and thus have the real as well as the apparent look of the normal "black-and-blue" spots following an injury. Indeed, the larger subcutaneous suffusions show the chromatic gradations of brown, green, and yellow at the periphery precisely similar to the "black-and-blue" mark, with the exception that in scurvy there may be distinct eleva-

tion of surface in severe hemorrhages, producing the papular acne scorbutica, or even terminating in the formation of vesicles. This latter condition may proceed to ulceration, which under a continued unfavorable hygienic and dietetic situation assumes grave significance. Indolent foul ulcers destroy at times a considerable area of cutaneous surface; or becoming dried and encrusted with an ichorous deposit, the condition termed scorbutic rupia ensues. This ecchymosis of the lower extremities, beginning at the ankles, is usually bilateral in point of appearance, and is accompanied by an œdema of the ankles and occasionally other cutaneous disturbances, as erythema. These ecchymoses extend from the lower extremity upward as the disease progresses in severe cases, and may appear in any situation on the body, though the face and scalp are rarely, if ever, involved in the hemorrhagic suffusions.

Hemorrhages into the deeper structures, the subcutaneous connective tissue (intermuscular or intramuscular), the fibrous tissues surrounding the joint, and even subperiosteal suffusions forming irregular nodes are to be observed. These deeper hemorrhages into the intermuscular tissues may be said to be the one particular symptom characteristic of scurvy. They may be detected as hard, painful swellings in the parts affected when they first occur. They feel like doughy masses shortly after the suffusion, and a sensible local elevation of temperature can be felt at times. These hemorrhages are in reality genuine hæmatomata, and the changes which occur in the parts affected may lead to subacute inflammatory conditions proceeding to necrosis of the soft structures, followed by the issue of a grumous fluid as the superjacent cutaneous tissue breaks down, and terminates in an ulcer. This, however, is an infrequent manifestation, as the hemorrhages are more uniform and diffused throughout the muscular structures below the knee, forming what the writer regards as the most marked feature of the disease, and one which is rarely mentioned by writers in the text-book treatises. Reference is here made to the cylindri-sanious infiltration of the subcutaneous tissues, the leg taking the form of an indurated cylinder, not pitting on pressure and lending to the sense of palpation the idea of a wooden leg. This is called the scorbutic sclerosis, and when once observed can never be forgotten, although it is not entirely easy to describe it satisfactorily.

Hemorrhagic suffusions into the mucous tissues are a less constant peculiarity. Bleeding from the buccal and nasal membranes is, however, a frequent and at times a serious exhibition of the progress and gravity of the disease. They come on without apparent cause, but may be stimulated or aggravated by local abrasions or injuries. It is difficult to control them, owing to the underlying condition of the

tissues, and exhausting anæmia may result from continued attacks. The mucous lining of the entire digestive tract may be locally affected by these hemorrhagic suffusions, leading to discharges of blood in the stools in severe cases. In like manner, suffusions into the serous membrane may occur. The kidneys, spleen, bladder, uterus, and other internal organs may be included in this process. In the scurvy of infants subperiosteal suffusions frequently obtain. Pulmonary infarction has been observed by some authorities. In a case recently reported there were corneal ulcerations in addition to ulcers in other situations, and it was of such a severe type that loss of sight was apprehended (Bailhache).

Articular swellings also occur, particularly of the knee and ankle, accompanied by the usual conditions of subacute arthritis, with tenderness, elevation of temperature, and ankylosis as a secondary manifestation. In the young, separation of the epiphyses sometimes occurs; and it is stated that there have been dislocations of the cartilages from the sternum. Even the disintegration of a recent callus has been reported. All these extreme results are the accompaniment of advanced and grave cases, and only require mention to show how far the constitutional disturbance may find expression in the destruction of tissues.

The condition of the digestive tract is usually that of constipation, frequently of an obstinate character. When diarrhœa is present, it often takes on the appearance of a dysentery, in which mucus and blood are found mingled in the dejections. The loss of appetite and distaste for the foods that constitute the diet induce nausea and vomiting.

There is no regularity of the temperature; sometimes it is subnormal when intestinal hemorrhages occur, or it may rise temporarily from the local disturbances due to suffusions or from the absorption of septic matter. The pulse is necessarily weak, and under exertion irritable or irregular. There may be heard the ordinary hæmic murmurs common to all profound anæmias, and in common with this dyspnœa is apt to supervene upon the slightest exertion. Besides the liability to infarction, there are no symptoms referable to the lungs. Secondary pneumonia or a bronchitis may develop late in the disease from septic infection.

In the nervous system there are no pronounced or pathognomonic manifestations. The character of the disease favors mental depression, and the patient is apathetic or oblivious to his surroundings. There is headache. Conditions approaching mania, convulsions, and coma have been noted by different writers. These are unusual, and indicate hemorrhages into the cerebrum. Among seamen the symptoms of hemeralopia and nyctalopia are characteristic of this disease, in the experience of the writer.

There are no changes in the condition of the blood that can be considered characteristic. The conditions that are observed in the secondary anæmias are usually found in severe cases, and when there are marked hemorrhages into the skin and deeper structures the red cells may be reduced to 557,875, as reported by Bouchut, but counts of 3,500,000 to 4,700,000 have been noted by other writers. The leucocytes are generally increased, either from hemorrhages or some other undetermined pathological process. The hæmoglobin suffers, as usual, more than the count of red cells (Cabot). The theory of Garrod regarding the diminution of potassium in the blood, which he pronounced a characteristic feature, had considerable vogue for a long time, but in the light of the modern morphology of the blood this lack is recognized as a constant condition in all forms of secondary or symptomatic anæmia, and is therefore of no particular significance. Ralfe and others held that a lack of malates, citrates, and lactates in the diet leads to a reduction in the normal alkalinity of the blood, which is largely dependent on their conversion into carbonates in the process of chemical metamorphosis. In the scurvy of infants the red cells may be reduced as low as 976,000, the hæmoglobin being 17 per cent. and the white cells 12,000, as reported by Reinert. Lymphocytosis may also be present in scurvy, and in any of the forms of the disease the blood-plates may be greatly diminished. Altogether, in the light of our present knowledge of the blood in this disease, the results of research thus far are of only negative value. The post-mortem appearances of the blood show it either thin and watery or in a condition of partial coagulation.

Diagnosis.—There is usually not much difficulty in recognizing scurvy when a number of persons are afflicted together in an institution or on shipboard under conditions favorable to the development of the disease. It is in the atypical cases, or where from the surroundings its presence would be unsuspected, that it would be classified under the diagnosis "debility" or "anæmia" by those not familiar with its character or causation. It may be confounded with some forms of purpura hæmorrhagica, with beri-beri, the secondary anæmias, and other like diseases marked by marasmus.

The main diagnostic points are the spongy condition of the gums, heretofore described, the subcutaneous and other hemorrhages, and the hard, brawny feel in the lower extremities, due to intermuscular and connective-tissue infiltration. There are no conditions affecting the gums in purpura, the spots are brighter, and there are no deep-seated hemorrhages in the latter-named disease. The differential diagnosis may be further made from purpura by the variation in the articular involvement, which is much less severe in scurvy. Cases from shipboard partially advanced, arriving from ports where beri-

beri is endemic, may require a differential diagnosis, particularly if the liability of the ship is involved for damages. The writer acted as professional witness in a case involving the point raised by the defence. In the œdematous form of beri-beri, in which the legs are swollen, with emaciation, the external appearances require the elimination of scurvy as a possible factor. It is sufficiently easy to separate scurvy from the secondary anæmias after obtaining a thorough and complete history of the case. In cases of doubt the diagnosis may be aided by the dietetic treatment to be hereafter described. It may be necessary, in the event of litigation in cases occurring on shipboard, to be prepared to combat allegations of syphilitic infection complicating the case, and to make a differential diagnosis between the syphilodermata and the cutaneous manifestations of scurvy, all of which should be easy for the average observer.

Prognosis.—In the ordinary sporadic cases met with on land the termination in recovery may be satisfactorily predicted as soon as the necessary corrective measures are instituted. The duration may cover several weeks, however, until health is restored; but it may be months before a complete return to normal standard can be expected. Recovery is affected by the environment, and recurrences favored by a persistence in having residence among the unsanitary surroundings that aided in its development.

In cases reaching port after long voyages the gravest conditions exist, and patients may die either of general exhaustion shortly after admittance to hospitals or from some intercurrent affection of the lungs or kidneys.

During the Civil War the mortality was 16 per cent., a rate that considerably exceeds the experience in our marine hospitals. Except in epidemics in campaigns, the mortality should not reach 5 per cent. under modern conditions of improved dietetic adjuvants, prepared foods, and canned vegetables.

Treatment.—From what has already been said, it is clearly established that scurvy is a preventable disease; and the treatment of it, therefore, resolves itself into two parts—prophylactic and curative—the first equally as important as the second.

PROPHYLACTIC.—There are two conditions under which the agencies for the prevention of scurvy may require to be applied—first, in the case of ships about to proceed on long, "deep-sea" voyages, such as merchant clippers sailing "round the Horn" without making port, whalers bound for Bering Straits to winter in the fjords and inlets where the "right whale" breeds, and in the increasing number of expeditions seeking the North Pole. In these cases the physician may be called upon to advise an antiscorbutic regimen which will insure to crews immunity from an improper diet. It is

not an infrequent occurrence for crews about to proceed upon any of the long voyages mentioned to apply to some professional authority, especially an officer of the Marine-Hospital Service, for an opinion upon the rations and stores provided by the ship's agents; and it is desirable to have some established or approved schedule, based upon scientific principles or experience, to guide the physician in case of consultation upon this subject. The laws of the United States cover in part some of the features of the case, and the following authority can be cited as to the requirements of this Government regarding the rations of seamen who are bound for a long voyage, as found in the Revised Statutes:

"SEC. 4569. Every vessel belonging to a citizen of the United States, bound from a port in the United States to any foreign port, or being of the burden of seventy-five tons or upward, and bound from a port on the Atlantic to a port on the Pacific, or *vice versâ*, shall be provided with a chest of medicines; and every sailing-vessel bound on a voyage across the Atlantic or Pacific Ocean, or around Cape Horn or the Cape of Good Hope, or engaged in the whale or other fisheries, or in sealing, shall also be provided with, and cause to be kept, a sufficient quantity of lime- or lemon-juice, and also sugar and vinegar, or other antiscorbutics, to be served out to every seaman, as follows: The master of every such vessel shall serve the lime- or lemon-juice and sugar and vinegar to the crew within ten days after salt provisions mainly have been served out to the crew, and so long afterward as such consumption of salt provisions continues; the lime- or lemon-juice and sugar daily at the rate of half an ounce each per day, and the vinegar weekly at the rate of half a pint per week, for each member of the crew."

Various attempts have been made by organizations devoted to the welfare of the sailor to induce Congress to improve a law (U. S. Rev. Stat. 4612) enjoining a specific daily requirement of articles and quantities for such purposes; and several years ago the writer was detailed as one of a board of medical officers to prepare an antiscorbutic ration to cover the weekly diet by days, articles, and quantities. The findings of the Board are tabulated on page 837, and are self-explanatory.

The aim of the Board was to schedule a ration that should not only effect the desired prophylaxis against scurvy, but also to make it a reasonable requirement for those obliged to provision the ship. It was estimated at the prices then prevailing that each ration would cost approximately twenty cents per diem per man. It is to be understood that a ration is a day's diet for a healthy man, and it will thus be seen that it could meet no objections on the score of cost from the shipowners. It was not enacted into law, however, for

TABLE OF RATIONS FOR SEAMEN.

Articles.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Substitutes.
Water (gallons)	1	1	1	1	1	1	1	
Biscuit, pilot, navy "X" (pounds)	½	½	½	1	½	½	½	1½ pounds of fresh bread or 1 pound of flour daily.
Fresh bread (pounds)	1	1	1	1	1	1	1	
Salted beef (pounds)	—	1¼	—	1¼	—	—	1	1¼ pounds of fresh meat in lieu of one ration of salted beef when in port.[1]
Salted pork (pounds)	—	—	1	—	—	1	—	1¼ pounds of fresh meat in lieu of one ration of salted pork when in port.[1]
Preserved meat (pounds)	¾	—	—	—	¾	—	—	1¼ pounds of fresh meat for each ration of preserved meat when in port.[1]
Potatoes or yams (pounds)	1	1	1	1	1	1	1	2 ounces of desiccated vegetables.
Flour	½	—	—	—	½	—	½	No substitute.
Beans, dry, white (pints)	—	—	¼	—	—	¼	—	No substitute.
Pease, dry (pints)	⅓	—	—	—	⅓	—	—	No substitute.
Rice (ounces)	6	—	—	6	—	—	—	6 ounces of hominy, cracked wheat, or oatmeal; or 2 ounces of tapioca for each 6 ounces.
Tomatoes, canned (pounds)	½	—	—	—	½	—	—	6 ounces of canned vegetables or 8 ounces of green cabbage.[2]
Fish, salted or fresh (pounds)	—	—	1	—	—	1	—	No substitute.
Coffee, green berry (ounces)	¾	¾	¾	¾	¾	¾	¾	Tea.
Tea (ounces)	⅛	⅛	⅛	⅛	⅛	⅛	⅛	Coffee.
Sugar (ounces)	3	3	3	3	3	3	3	No substitute.
Molasses (pints)	—	½	—	½	—	½	—	No substitute.
Dried fruit (ounces)	—	3	—	3	—	—	3	6 ounces of canned fruit or same quantity of fresh fruit.[2]
Pickles (pints)	¼	—	¼	—	—	¼	—	No substitute.
Vinegar (pints)	—	½	—	—	½	—	—	½ ounce of lime-juice daily.
Pepper, black (ounces)	1/7	1/7	1/7	1/7	1/7	1/7	1/7	Cayenne pepper.
Mustard, ground (ounces)	1/7	1/7	1/7	1/7	1/7	1/7	1/7	No substitute.
Salt (ounces)	4/7	4/7	4/7	4/7	4/7	4/7	4/7	No substitute.
Cornmeal (pints)	—	¼	—	—	—	—	¼	4 ounces of oatmeal or cracked wheat for each ½ pint.
Onions (ounces)	4	—	—	—	4	—	4	2 ounces of pickled onions for each 4 ounces.
Lard (ounces)	1	1	1	1	1	1	1	No substitute.
Butter, canned (ounces)	1	1	1	1	1	1	1	Same quantity of butterine.

reasons disconnected with the intrinsic question involved; but the table is here incorporated as a guide for those who may be called upon to prescribe a dietary regimen for ships proceeding upon long, deep-sea voyages. The quantity of the ration varies daily from 5 pounds 1 ounce to 5 pounds 9⅞ ounces.

The various Arctic explorers have left to us in their writings their opinions regarding the scorbutic affections with which they had to contend. Hall and Kane both stated that fresh, raw meat was a preventive of scurvy, while cooked meat was not. Some of the

[1] These substitutes are obligatory.
[2] Fresh fruits and vegetables to be served while in port.

early Arctic navigators approvingly mentioned the virtues of spoon-wort (Cochlearia officinalis) as an antiscorbutic; and one of the latest explorers (Nordenskjold) advises the use of cloud-berries (Rubus chamœmorus). It is not believed that any of these plants, or any others of the *Cruciferæ* family, have specific value as antiscorbutics, and reliance should not be placed upon them when other and better means are obtainable.

The second condition under which prophylactic agencies may be applied is in the case of large institutions for the poor, in which for economical reasons the diet is expected to be restricted to the actual necessities, lest numbers of beneficiaries be attracted to resort to the conveniences afforded by them on account of a too liberal *ménu*, or those already within find it pleasing to remain by reason of continued gastronomic attractions. Such institutions always have a physician in attendance, and it will be his duty, or of some medical officer attached to boards governing the poor and indigent, to give advice upon the quality and quantity of food requisite for the individual confined in such establishments. It will be proper to discriminate between necessity and liberality; and, in order to avoid the occurrence of scorbutic symptoms among a portion of the ill-conditioned inmates, such as would arise from a too restricted or a long-established regimen of one class of foods, the physician must see that there is a judicious variation in the daily diet schedule. This can be accomplished without subjecting him to the criticism of catering to the palate rather than to the alimentary necessities. It need hardly be said that this regimen should not only include fresh vegetables, but, what is more to the point, in the writer's opinion, fresh meats also. In such institutions will always be found a large proportion of the inmates in advanced life, others with feeble intellect, and others laboring under the depressing and hopeless surroundings of the place. These persons will voluntarily or involuntarily confine themselves to a certain portion of the prescribed diet for a long period, and after a while develop signs of scurvy, to the great scandal of the institution. It will be the province of the attending physician to consider cases of this sort, make the proper diagnosis, and apply the necessary corrective measures to be outlined hereafter.

Curative.—Primarily, the therapeutic indication in scurvy is one of dietetics more than medication, although there are varied conditions requiring the administration of drugs to alleviate some of the distressing symptoms of the disease. It is not enough to say that the diet should be corrected, for it must be done with reference to the special situation in which the patient is found. The environment must be considered as a factor in the case, and the local conditions changed if they be at fault.

While scurvy is usually an accompaniment of poverty when found on land, it is not always feasible to improve the dwellings in which cases may be found; but some of the more pronounced unsanitary agencies may be modified in respect to ventilation, cleanliness, or cooking. If practicable, the cases should be taken to a hospital where good nursing and a proper dietary regimen may be had. In the case of sailors on shipboard, they are not seen until port is made, when relief can be had in the hospitals provided for their care. Respecting cases occurring in institutions, the requisite means should be had to insure immediate amelioration in the matters of errors of environment.

When the patient is first seen, the external conditions of the case must be attended to; and, if able to bear it, a warm bath should be given, then clean clothes and a bed. Food is to be administered cautiously at first, as the strength of the patient is at times materially decreased to the danger-point, and the stomach is too weak to digest and assimilate anything but the blandest diet in the smallest quantities. The first indication, of course, is the exhibition of fresh vegetables; and this can best be done in the form of a vegetable soup well strained, for the condition of the gums and teeth may be such that chewing cannot be accomplished without pain and hemorrhage. To this should be added a relish from time to time, the juice of lemons or limes, preferably the former, two or three daily. Spinach, boiled, is an excellent and nourishing vegetable, having not only the advantage of a softness in consistency, but containing preeminently the elements necessary for building up the starved tissues. Pickles, sauer-kraut, and the vegetables used as "greens" with vinegar are valuable as substitutes for the ones mentioned. If the patient is able to masticate, the writer has found that the dish known as "cold slaw" (finely chopped, uncooked cabbage and vinegar) acts excellently and is greatly relished by the sufferers. Attractive to the eye as well as the taste are lettuce, water-cress, and sorrel; and these should be fed judiciously in increasing quantities, varied with the leguminous and amylaceous vegetables. Reliance, however, must not be placed entirely upon vegetables as an exclusive dietetic agent. The patients may baffle the theory of causation entirely by exhibiting a strong disinclination to partake of the vegetable diet, including lemons, limes, and oranges; and it may be necessary to force them to follow instructions. Or if this does not meet the case, resort can be had to an almost equally efficacious regimen in fresh meats, soups, and milk. While scurvy does not occur among those whose food includes vegetables, yet the necessity for a variety must be borne in mind. The reduced and starved body requires the stimulus of a variegated diet as well as in health, and fresh eggs, milk, and meat,

broths, and soups (well strained) must be used as adjuncts as soon as possible after a trial of the digestive capacity. In this stage of the constitutional treatment it is particularly essential that the entire strength of the patient should be conserved by complete rest and good nursing. While the dirty, ashen hue of the skin, the pale, bluish lips and nails remain, watchful care must be had over the case lest the strength be taxed.

As a general tonic plan of treatment is indicated, this may be met by the exhibition of any one of the bitter vegetable tonics, by iron, or dilute sulphuric acid, and these should be given for some time after the acute symptoms have been ameliorated.

In the Marine Hospital at San Francisco a favorite and efficacious tonic mixture was composed of the tincture of ferric chloride and chlorate of potassium. The latter salt was put into the former and a saturated solution made, generally leaving a small quantity of the potash crystals in the bottom as an index. The usual dose of this preparation of iron was administered, and its effect was most satisfactory. Under it the patients rapidly acquired a healthy color, the mucous membranes of the lips and conjunctivæ grew to the natural red hue, and general improvement in strength was rapid.

The treatment advocated by Garrod, previously referred to, namely, the exhibition of potassium by one of its salts, the nitrate or bitartrate, is not now considered as of any particular value. It also used to be regarded as desirable to administer iron in the form of a citrate, as being a salt especially adapted to scorbutic conditions; and it may be that it possesses additional advantages from the citric acid in its composition.

One of the first symptoms usually demanding relief are the spongy and bleeding gums. While they will promptly show the results of a corrected diet, yet the softened tumefaction needs relief. If it is slight, the juice of lemons will afford enough astringency to answer the purpose; but severe cases require more pronounced astringents, such as tincture of catechu or krameria, which may be brushed on the spongy mucous surfaces. In the event of ulcerative conditions obtaining, the small patches may be treated with powdered alum, while the writer has seen cases in which lunar caustic had to be used to assist in repairing the damage to the mucous membrane. The solution is advised as better than the stick for use in the mouth. Pencilling with a camel's-hair brush enables the operator to reach crevices between the teeth.

Correlated to this condition, and requiring adequate measures to correct it, is the offensive odor of the breath, unbearable alike to the patient and those in attendance. Gargles and mouth-washes may be made of potassium chlorate in dilute solution, which acts promptly in

controlling the fetor as well as stimulating the mucous membrane to healthier action. A little tincture of myrrh may be added with benefit for its aromatic qualities.

Euthymol, or any similar antiseptic preparation, to which a weak solution of formaldehyde may be added, can be used with benefit in modifying the foulness of the breath and arresting the development of putrefactive organisms in the mouth. Other agencies, such as solutions of chlorine and iodine, are suggested, and cases may arise in which they would prove efficacious; but it is doubtful if they would not prove so distasteful as to be contraindicated. The fetor of the breath is a condition that soon changes for the better, and harsh measures for its correction need not be employed. There may be some stomatitis and reflex salivation as secondary conditions, the former of which may be treated locally with solution of potassium permanganate, and the latter internally with belladonna or atropine.

There are no gastric symptoms which require particular attention in the ordinary cases. Nausea and vomiting, due to a distaste for the foods previously composing their diet, will soon be stopped by the proper aliment that has heretofore been lacking; but if it continues, measures should be adopted to stop emesis and retching. Gastric sedatives, such as bismuth, dilute hydrocyanic acid, or the carbonated waters, will benefit the case materially, and should be exhibited. If the appetite be lacking in keenness, or digestion feeble, some bitter stomachic tonic, such as gentian, cinchona, or strychnine, may be advantageously administered to regain the necessary tone to the digestive system.

The two opposite conditions of the intestinal tract, laxative and constipated, are met in various cases of scurvy, and must be treated with care. Astringents, such as catechu, krameria, or in obstinate cases opium combined with acetate of lead, will usually correct the diarrhœa until the normal state of the gastro-intestinal tract returns with the changed diet. Constipation need not give so much concern, and should not be harshly corrected by the administration of powerful cathartics. After a day or two under the changed diet if the bowels do not move, an enema will usually be a sufficient stimulus to continued natural action. If constipation continues, salines will best answer the purposes of mild purgatives, but they should be reserved as long as possible lest a diarrhœa be set up by their action. In the writer's experience, the return to proper diet, by supplying the system with vegetable acids heretofore lacking, acts as a sufficient corrective agent to either the ordinary constipation or the diarrhœa found in scurvy.

For hemorrhages there is no satisfactory remedy known, and it is doubtful if any of the so-called hæmostatics have any effect. It is

well, however, to give them and the patient the benefit of the doubt, and whenever there are intestinal discharges containing blood to give iron, ergot, acetate of lead, or turpentine, as the case seems to indicate. In order to increase the coagulability of the blood chloride of calcium (crystal) may be given in doses of 20 grams three times daily. If the patient be very anæmic when first seen, and continues to show evidences of hemorrhagic suffusions, and loss of blood by the intestinal tract and nasal or buccal surfaces, subcutaneous injections of the normal saline solution can be administered with marked benefit. This method will prove quite as satisfactory as by enema. The latter can be employed in graver conditions, but is likely to irritate the lower bowel when there are frequent stools of a dysenteric character.

The stiffened joints should be treated by massage to stimulate the skin and deeper structures, and by passive motion of the articulating surfaces, increased daily. At the same time similar measures may be taken to promote the absorption of ecchymoses of the lower extremities by gentle and cautious friction. If it proves efficacious, the deeper suffused hæmatomata may be treated in the like way. Massage may also be advantageously employed in the convalescence of severe cases, in which the shrunken muscles need stimulation to regain their lost form and tone.

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